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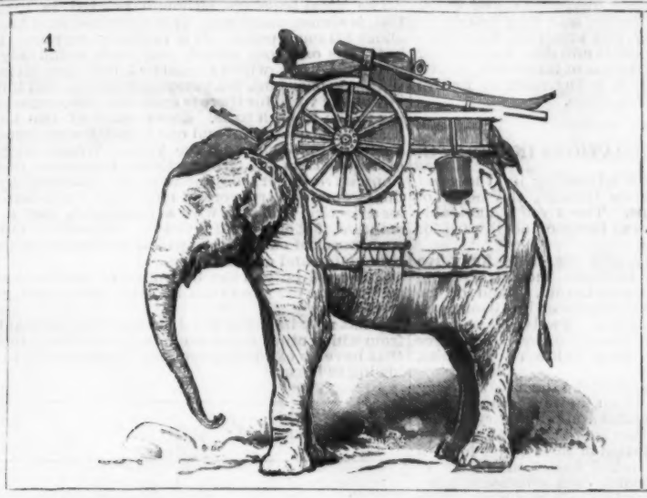
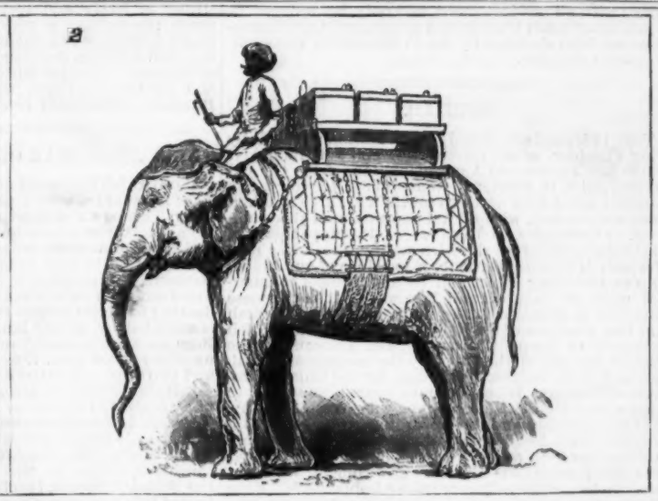
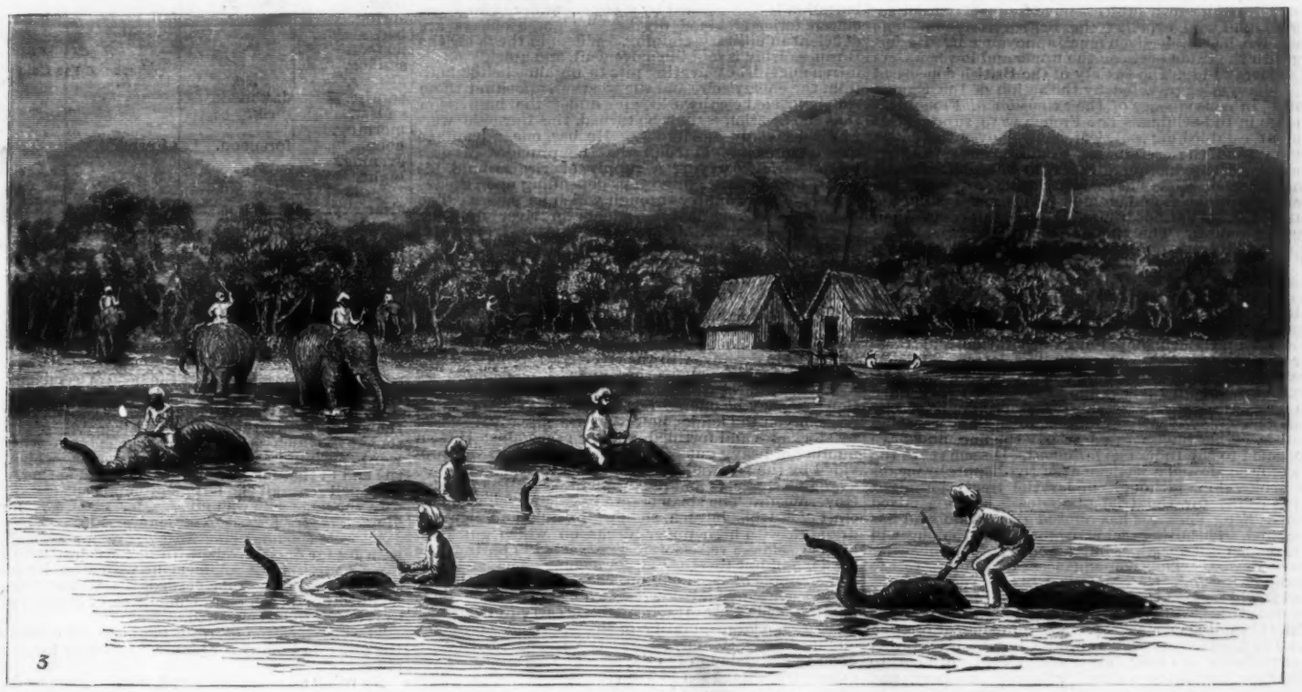
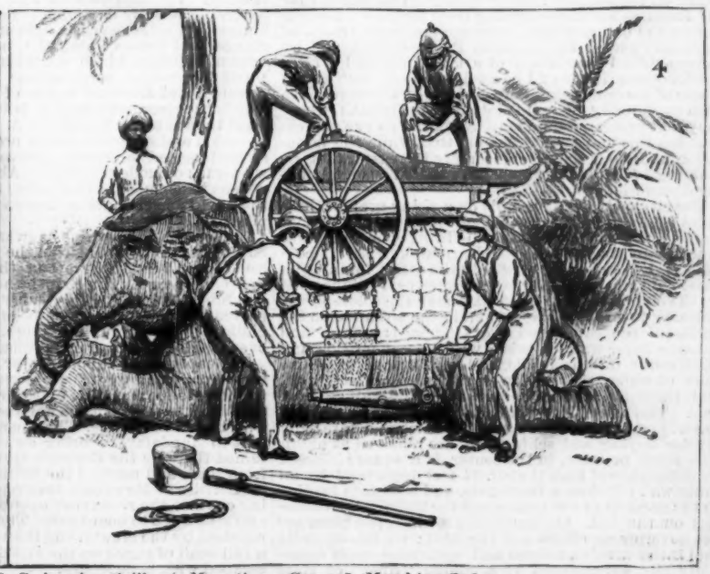








1. Gun Elephant. 2. Ammunition Elephant. 3 Swimming Drill. 4. Mounting a Gun. 5. Marching Order.

THE BRITISH WAR IN BURMAH.—AN ELEPHANT BATTERY AT TONGO, EASTERN INDIA.

BRITISH ELEPHANT BATTERY, BURMAH.

THIS battery is of peculiar interest just now, as it is situated at Tongo, a town in the Tenasserim district of British Burmah, and would take a leading part in any hostile operations. The nominal strength of a battery is placed at twenty-two elephants and four guns. These are disposed as follows: Four are attached to the guns, twelve carry the ammunition, four the artificers' tools, and two are kept in reserve for emergencies. Weekly parades are held, and the spectator is at once impressed with the thorough training and the readiness with which all orders are understood and obeyed. The swimming drill, which is also held weekly, is a most trying task for the mahout, and it is not uncommon to see an elephant back out of the water and take to the jungle with all possible speed, and only be induced to return after much trouble and persuasion. Our illustrations are from sketches by Mr. F. Rencontre, Rangoon. —*London Graphic.*

BURMAH.

THE independent kingdom of Burmah, ruled by King Theebaw, whose capital is the city of Mandalay, which has superseded Amarapoora and Ava, the old capital cities, is restricted to an inland territory, five hundred miles from north to south, and three hundred from west to east, with a total population of three millions. It occupies, to that extent, the upper part of the basin of the great river Irrawaddy, the lower part of which is British Burmah, a province of our Indian empire, including Pegu, and having its chief commercial ports at Rangoon and Moulmein. The Burmese kingdom is bounded to the south by British Burmah and the kingdom of Siam, to the west by the British provinces of Assam, Chittagong, and Arracan, on the Bay of Bengal, to the north by the mountains of Thibet, and to the northeast and east by the Chinese province of Yunnan. It has for many years been sought to open a road for British commerce with Western China through Burmah, and the attempts of travelers in that direction have cost several valuable lives; but the opposition has been rather from the Chinese local authorities than from the Burmese government, which is, nevertheless, extremely corrupt and oppressive. King Theebaw, a ferocious and sanguinary tyrant, whose massacres of his own subjects have frequently been reported, and who expelled the British residents some years ago, has lately given much annoyance by interfering with the trade between the upper and lower waters of the Irrawaddy. The anxiety of the British concerned in India was aggravated by the action of the French consul, in consequence of the extension of French influence in Indo-China. The French were supposed to aim at establishing political control over the entire region from the eastern sea to the Burmese frontier, including the reduction of Siam to a dependent state. One object of King Theebaw has been to secure the transport of arms and ammunition through Tonquin, but, so far, he has not been able to obtain more than vague promises. The French consul in Burmah was reported to have obtained concessions for the making of railways, offering large interest, and proposing to take as security the customs. A bank also was suggested to manage the tea trade and work the ruby mines. Finally, some Frenchmen had offered a large sum, provided the king would cancel the leases of the Bombay and Burmah Trading Corporation, and transfer them to a French company. The latter statement seems to explain the recent decree against the corporation, imposing on them a fine of £230,000. They have an immense body of servants and hundreds of elephants employed in the forests cutting and carrying timber. They have refused to pay the fine, and have appealed to the Indian government. It seems that the Viceroy suggested a settlement of the dispute by means of arbitration, although under the treaty he might have called for the trial of the case before a mixed court. King Theebaw has refused arbitration, and has declared, in insulting and arrogant terms, that he will not reopen the question, but at once enforce his arbitrary decree. The consequences, of course, to the Bombay-Burmah Corporation will be very serious, and it will be seen that the Indian government cannot tolerate them. Before dispatching an ultimatum, the Chief Commissioner asks for a re-inforcement of from 5,000 to 8,000 troops. These would not all be required to overthrow the king, but it would not be prudent to enter on hostilities without adequate support, and ample means for the repression of brigandage sure to follow on the heels of regular warfare. It is stated that the Burmese are strengthening their frontier. According to the best accounts, there are really no troops of any value except the so-called Palace Guard, and by the combined operations of a land force and a river flotilla opposition would be easily quelled. During the whole of his cruel reign, the subjects of Theebaw have been continually migrating into British Burmah, where they find protection and employment. To such an extent has this movement gone on, that while the population under our control has largely increased, that remaining in Upper Burmah has suffered a corresponding diminution.

The city of Mandalay, built on a rising ground three miles from the great river, which is full of native boat traffic, and is connected with the town by a canal, was founded by the late king of Burmah in 1853. It consists of two squares, one within the other, forming an outer and an inner city. The outer part is inhabited by the civil and military officials and the soldiers; the ordinary town population dwell in the suburbs, on the banks of the canal and river. There is a high and massive outer wall, of brick, with a moat outside and earthworks on the inside, and with four gates, above each of which rises a tower with seven gilded roofs, and there are smaller towers along the wall at intervals. The houses stand in separate inclosures, bordering wide and well kept streets, in which stalls are daily set for buying and selling, but are removed at night. The royal precinct, in the center, is a square inclosed by a stockade of teak timber, 12 feet high, and by an inner wall; it has a front gate, and a postern leading to the gardens of the palace and the Buddhist monasteries on the hill. On one side of a wide open place are the government offices and the mint; on the opposite side is the king's audience hall, with nine roofs splendidly gilt, surmounted by a golden "htee," or state umbrella, with a coronal of tinkling bells; to the left is the stable of the White Elephant, which animal, as Londoners know, is not really white, but has pale blotches about its head; to the right is the Royal Arsenal, with the model of a ship of war, to serve as a school of naval gunnery. The entire population of Mandalay is reckoned at a hundred thousand. The Burmese race, who are but one-third of the people of the kingdom of Burmah, are of primitive Indian extraction, belonging to the Turanian family of mankind, and akin to the nations of Nepaul, Thibet, and Siam; their language is an offshoot of Pali, mingled with Tartar and Chinese words. They are of the Buddhist religion, and their monarchs, claiming descent from the Sakhya founders of that religion in Hindostan, have a sacerdotal authority. The people are robust and strong, of lively and sociable disposition, and enjoy much plenty from a very fertile soil; they delight in feasts and shows, in racing and wrestling, cock fighting, bull fighting, dancing, cards and dice, and playing at football. We give illustrations of their carts, boats, and costume or dress, which is the same in British Burmah.— *Illustrated London News.*

THE BRITISH WAR OPERATIONS IN BURMAH.

THE British forces are now advancing up the great river Irrawaddy, which passes through the heart of King Theebaw's dominions. The river is navigable from the British possessions at Rangoon northward for a distance of over 800 miles.

The flotilla is now ready, and comprises forty-five steamers, flats and floating batteries, the latter being fitted out from six of the largest barges. Each of the floating batteries carries two 6-pounder howitzers and is attended by armed launches. Twelve 25-pounder siege guns are mounted on the steamers. The force numbers 10,000 men, 7,000 camp followers, 500 mules, and two elephant batteries.

It is stated that the strength of the Burmese standing army is about 10,000 men, which, however, can be considerably increased by irregular and temporary levies. The army is almost altogether lacking in both cavalry and artillery. The constitution of the regular force is somewhat similar to the linked battalion system of the British infantry, two bodies, each 500 strong, being linked into something equivalent to a regiment. The battalion is commanded by a bogyi, under whom are officers termed "blood drinkers." These officers are deficient in military training. When in the field, the Burmese army is rapid in movement, and quickly forms intrenchments, excavating pits to obtain shelter both from the enemy's fire and the weather. Behind these rudely formed earthworks, and under the impression that the position cannot be turned, the Burmese warrior is decidedly dangerous. He has one advantage over a more civilized foe in that he provides his own commissariat, carrying a supply of rice around his waist, and for other provisions depending upon the resources of the country through which he passes. The Burmese are regarded as adepts in river fighting. There are a number of war boats on the Irrawaddy, mainly supplied by towns and villages along the river, which are under obligation to provide a certain number of boats, with their crews of rowing and fighting men, from fifty to seventy of whom are carried by each boat. In the last Burmese war, a geat deal of annoyance was caused the English by fire boats, freighted with highly inflammable material. Comparatively little difficulty in dealing with the river craft is now anticipated. Machine and other guns, supplemented by rockets, will probably make short work of the opposition that may be offered on the river. Commanding positions on the banks, however, are already inclosed by stockades and fortified, and for use against these a number of heavy guns are carried. Transport was provided by the Irrawaddy Flotilla Company, all of whose available steamers and flats were hired by the British Government. The steamers are paddle-wheel, spacious craft of 500 tons burden, shallow in hull and light in draught, with high upper decks, on which guns are carried. These vessels were constructed in parts on the Clyde, and put together at Rangoon. The steamers tow a couple of flats, one on each side. The latter, with their corrugated iron awnings, resemble huge floating sheds, and are each capable of carrying nearly 600 men, with a large quantity of stores. Under ordinary circumstances, steamers make the passage from Rangoon to Mandalay in ten days. The distance is 502 miles; from Rangoon to Thayetmayo, 240 miles (three days); Thayetmayo to Ava, 250 miles; Ava to Mandalay, 12 miles. The river swarms with native craft, and is navigable only by daylight. For nine miles above Thayetmayo the river is a mile and a half broad, with villages and houses lining the banks of the winding stream. Minhla, which contains 5,000 inhabitants, is about thirty miles north of the boundary of British Burmah, and 225 miles south of Mandalay. It commands the river, and until it is taken no advance beyond the town can be made. A fort of modern construction and scientific design occupies the river, and its well-formed earthworks are tolerably well mounted with guns of modern caliber. Above Minhla the river widens to as much as four miles, but it is shallow, and the navigable channel is known only to experienced pilots.

In a recent fight with the war vessel belonging to King Theebaw, the fire from the British steamer Kathleen caused 200 of the crew of the Burmese vessel to jump overboard. The British then boarded the vessel, and proceeded up the Irrawaddy with her. It is reported that 3,000 Burmese troops are stockaded at Fort Kuligon, which occupies a high, dominating position overhanging the river at Minhla.

The capture of the man-of-war will prevent the Burmese from placing further obstructions in the river, or moving troops and guns by the river route, and will disabuse the minds of the natives of the idea that King Theebaw is invincible. The steamer Doowoon, recently sent to Mandalay to bring away the Europeans detained there by the Burmese Government, has escaped from there and reached the British lines. When the authorities at Mandalay discovered the Doowoon moving out into the river, they opened a heavy fire on her and sent force to board her. The boarding party were repulsed by the crew of the Doowoon, and having got a full head of steam on the vessel ran the gantlet and escaped with little injury.

THE VIDAL LANGUAGE.

To the Editor of the Scientific American:

In the SCIENTIFIC AMERICAN for September 19 is an article about a new language, "Volapuk." I had a description of it from Europe a few years ago. After comparing it with some other languages, I found that it was not so good as the languages proposed by Messrs. Vidal, Sudre, and Magaren, that I had examined before.

At a meeting of teachers in Stockholm, Sweden, nearly forty years ago, I proposed that efforts be made to produce a perfect language. I have since seen many attempts to make such a language, but, although some of them are far better than any of the languages in use, it is not impossible to make one that is still better.

The Vidal language, although printed in Paris in 1844, is almost unknown. It is contained in a book of about 400 small pages. It is perfectly regular. Each letter has only one sound, and each sound only one letter. A word which consists of only one letter, if that is a consonant, is a personal pronoun; and if it is a vowel, *the* verb, for there is only one verb, corresponding to the English to *be*. Every word of two letters, that is, one consonant and one vowel, is a compound of a personal pronoun and the verb. Words composed of three letters are either articles, pronouns, prepositions, adverbs, or conjunctions, as indicated by the final letter. Every word of more than three letters is an adjective if it ends with a consonant, and a substantive if it ends with a vowel. Adjectives are also such words of one syllable which commence with two consonants and end with one.

H is used only in the beginning of interjections, of which there are more than in other languages generally.

What may be called the dictionary for substantives, from which other words are formed according to rules that have no exception, occupies 236 pages, like the following 22 lines:

Se.

n.	*d.*	*t.*	*tr.*	
season.				y
time.	weather.			u
spring.	summer.	fall.	winter.	e
bad season.				a
meteor.				i
sundog.				o
r.	*g.*	*k.*	*kr-*	
sunrise.	daybreak.			y
sunset.	dusk.			u
morning.				e
noon.	forenoon.	afternoon.		a
evening.				i
night.				o
m.	*b.*	*p.*		
clear sky.	sunshine.			y
cloud.				u
fog.				e
mist.				a
rain.				i
shower.				o

As is seen, every page is divided into three or more columns, every column into three parts, and each part contains six lines. At the head of each page is one syllable. A consonant is at the head of each part of a column, and a vowel is at the end of each line.

To find what spring (of the year) is called, take first the syllable *se* at the head of the page, then the consonant *n*, which stands over the column where the word spring is, and add the vowel *e*, which is at the end of the line containing the word spring. This will spell *sene*, all the letters pronounced.

In the same way we find *sera* for noon, *seri* for evening, *seme* for fog, *semo* for shower, etc.

All words commencing with *B* are for animals, and with *Bu* for quadrupeds, with *Be* for fishes, with *Ba* for insects, etc. Words commencing with *Z* are for plants.

As new words become needed, the vacant places will be filled up, for which a committee of competent persons ought to be consulted.

The classification of words ought to be according to the order in botany for plants, in zoology for animals, etc.

By using all consonants and some compounds, such as *br*, *dr*, *fr*, *gr*, *kr*, *pr*, *tr*, *vr*, *bl*, in proper order will be a sufficient number of words, far shorter than in other languages.

FRANS HERMAN WIDSTRAND, editor *Radical.*
Litchfield, Minnesota,
September 30, 1885.

THE EMERY MINES OF ASIA MINOR.

Report by Consul STEVENS, of Smyrna.

IN a report which I had the honor to make to the Department under date of March 24, 1884, I submitted some facts with reference to the emery mines of this consular district, a large portion of the product of which is shipped to the United States, where it is used for various manufacturing and industrial purposes, chiefly, however, for the polishing of metals and glass. Since then I have, as a result of diligent inquiry, become possessed of additional information, which may not be without value to our people.

Although emery stone is found in nearly all parts of Asia Minor, and not unfrequently in the remote and almost inaccessible regions of the interior, where the natural obstacles are too great to offer any inducement to the miner, the principal mines are confined to the districts of Thyra and Aidin, situated to the southward of Smyrna, and not far distant from the line of the Ottoman Railway. These are known as: The Tchavus, within one hour's ride from the town of Thyra, owned by Mr. Frederick Charnaud; the Hassan Tchaouslar, owned by Mr. Jackson; the Aladjali Tchiflik and Kourchak, owned by Mrs. Abbot; the Halka or Saladin, owned by Mr. Frederick Charnaud; the Akdere, owned by Mr. Glyka; and the Gurnush Dogh, owned by Mrs. Abbot.

There is another mine near Milassa, the stone from which is brought for shipment to a place on the coast

called Kuluk, near the Gulf of Mendalia. It is either shipped direct from that place to foreign markets or brought to Smyrna in a small sailing craft for reshipment.

When well picked and freed from unsound ore and rubbish, the emery from the Charnaud, Jackson, and Abbot mines is of good and nearly equal quality. The Glyka or Akdere stone is not as much sought after, while that excavated near Milassa, the larger part of which finds purchasers in the United States, is of inferior quality, the grain being smooth and a great deal of magnetic iron entering into its composition.

The amount of stone annually shipped from Smyrna to Great Britain, the United States, France, Germany, and Belgium aggregates about 7,000 tons, the relative quantity consumed in each country being in the order named.

In the matter of quality, manufacturers in France and Germany are extremely particular; they will have none but thoroughly picked stone, and will willingly pay the highest prices to obtain it. In France, especially, Naxos emery, considered to be the best in the world, is used to the almost complete exclusion of all other kinds. In Great Britain, also, purchasers are particular as to quality; but in the United States, especially within a few years past, importers have encouraged the shipment of inferior or uncleaned stone, because of its lower price.

cases the mining, is attended with difficulty and expense.

At the Jackson mine, for example, the stone is procured from a great depth covered with water, necessitating the employment of a steam-pump. At Kourchak, owned by Mrs. Abbot, not even blasting is required, the emery being dug up from the red argillaceous earth wherewith it is mixed.

The coating of the stone varies with the color of the earth or rock in which it is found—from red to brown, gray, or white; and as a rule no correct judgment of the quality can be formed from its outward appearance.

But the grain must be closely examined. This should be hard, bright, and coarse, resembling gunpowder, and varying in hue from reddish black to dark bluish gray. The grain must be tested before one can certainly know its eating power, which it has been ascertained does not solely depend upon the amount of alumina it contains, but also upon the particular way in which the molecules or particles have been placed by nature. In the Tchaous concession, near Thyra, a great deal of the emery is not mined, owing to the presence of mica in the grain.

The emery is picked daily at the mines as fast as it is extracted, in some instances not one-half the quantity being selected. It is then conveyed by camels to the nearest railway station and from thence to Smyrna, where it is generally picked again previous to shipment. When the mines are situated on heights inaccessible to camels, the ore is brought down to the plain by donkeys. If the pieces are too large to be carried by camels, they are brought to the station in carts drawn by buffaloes. But these very large pieces are broken at the mines with sledge-hammers, after having been subjected to the action of fire to facilitate their breaking.

The railway rates are rather high; from Thyra to Smyrna, for instance, a distance of 60 miles, the charge is equal to $3.36 per ton; and from Cosbonnar, the railway station from which the greater part of the ore is brought, and distant 41 miles from Smyrna, the rate is $2.20.

The mines are worked upon the strength of concessions, termed "firmans," granted by the Imperial Government for a period usually of ninety-nine years, or in cases where the emery has been found on "nacouf" property, *i. e.*, belonging to the Turkish religious institutions, by special permit of the department at Constantinople which administers the "nacouf" estates, and exacts payment to them of so much per kintol. A "firman," or concession, during the period it is in force can be sold, transferred, and transmitted by inheritance, like other property in Turkey, provided due notice be given to the department of mines at Constantinople, and authorization formally obtained.

The obtainment of a "firman" is at all times attended with difficulties, loss of time, and expense. According to by-laws on mines, the formalities to be accomplished appear very simple and the cost of the concession reasonable, but an applicant soon finds out all this to be a delusion. Its obtainment is at present still more hard and tedious to Europeans, owing to the reigning Sultan being averse to granting concessions to subjects of foreign governments, although the grantee would always be amenable to Turkish law in all matters having reference to his concession.

The difficulty can, however, be avoided by making the demand in the name of an Ottoman subject, and it would facilitate things all the more if he be besides a Mussulman. At all events, it is almost absolutely necessary that the demand of a foreigner be at least made jointly with an Ottoman subject, so that the latter's name may be also inserted in the firman presented for imperial sanction.

NAXOS EMERY.

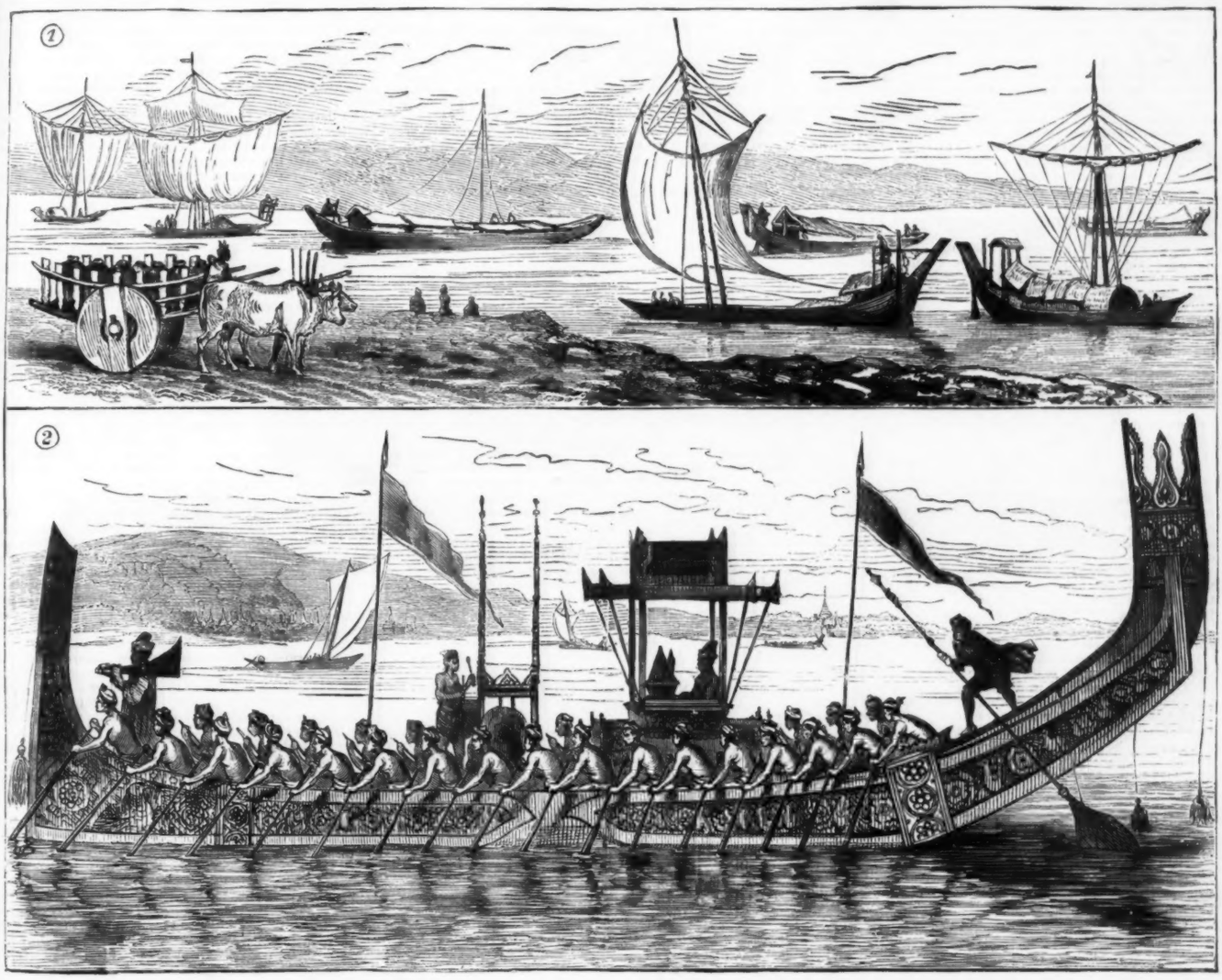
The emery in the island of Naxos is farmed or let out by lease to firms or private individuals by the Greek Government for periods of twelve consecutive years. Sealed tenders are sent in by persons wishing to compete, and the contract is adjudged to the highest bidder. The party who obtains the monopoly for twelve years has to deposit forthwith in the National Bank of Greece $19,300, to remain there as a guarantee for the fulfillment of his engagements during the whole period. He has to bind himself to take a minimum of 1,650 tons annually, at $42.50 per ton put free on board at Naxos, for the emery just as it is excavated, without selection.

The lessee is free to take double or triple the quantity if he wishes, but is obliged to take at least 1,650 tons. Formerly the price was higher and the minimum quantity fixed larger, but the contractors lost money. The lowest price at which Naxos emery could then be had from them was $48.70 per ton put free on board at Syra.

The greater part of the emery has to be brought to the neighboring island of Syra, in sailing vessels, at the contractor's expense, from whence it is reshipped. Steamers or large vessels cannot load at Naxos, except during the fine season, owing to the absence of shelter, which renders the operation dangerous. The contract of the present lessees, a Greek firm of Syra, has still about seven years to run. They will not sell to any one free on board, as their predecessors did, but have agencies and stocks in the principal markets of Europe and the United States.

For many of the foregoing facts I am indebted to Mr. Herman Keun, of this city, a gentleman who has made a study of the subject, and is esteemed an authority thereon. W. E. STEVENS, *Consul.*

United States Consulate, Smyrna, May 7, 1885.



1. Native boats on the Irrawaddy; native cart on the river bank. 2. The Burmese Minister's State Barge (from a native's drawing).

THE BRITISH WAR IN BURMAH.—BOATS ON THE IRRAWADDY RIVER.

Good clean lump emery-stone can be contracted for here on board ships at $19.50 to $20.70 per ton of 2,240 pounds, and the same quality but in smaller pieces, say 1¼ to 1½ inches, at $3.65 per ton under these figures.

The rates of freight for emery-stone shipped in bulk by steamer to the ports of the north of France, the Netherlands, and Germany are from $3.90 to $4.38 per ton; to London, $2.33 to $2.92; to Liverpool, $3.90 to $4.87; to New York or Boston the freight is $1.22 to $2.44 per ton. Sailing ships with cargoes of licorice root require ballast, and so the stone is readily taken at almost a nominal freight.

The customs duty is only 16 cents per ton, but as "backsheesh" is indispensable in all dealings with Turkish customs officials, this charge is equivalent to 25 cents.

The quay dues are 4 cents per ton. The Turkish Government levy a duty or royalty of $3.21 on every ton of emery shipped. In addition, the grantee must pay a tax of 2½ cents per acre on the area of land ceded him by his firman.

The mines are opened by wells and galleries, and the stone is obtained in most instances by blasting, gunpowder and dynamite being freely used to extract it from between blocks of marble or masses of granite.

The overseers and principal workmen at the mines are Italians, who are paid 82 cents per diem; the native workmen are paid only about half as much. In some

DUST BURNING FURNACE.

A FURNACE for burning dust fuel has been brought out by M. Michel Perret in France, and is being introduced in England by B. Donkin and Co., London, who have fitted one to their own boiler in the manner shown by the engravings below, says *Engineering*. The fuel there used is the dust obtained from the screenings of gas coke, and is about the size of coarse sand, but the furnace is suitable for the combustion of the screenings of coal and anthracite, and for other fuel which will fall between the bars of an ordinary grate. The three noticeable features are: (1) that the ash-pit is closed and is worked under an air pressure obtained by a steam jet; (2) that the bars are very narrow and exceedingly close together; and (3) that the bars are very deep, and dip at their lower edges into water troughs. The air blast is obtained by a steam jet of the usual construction, and is conducted by a trunk into the space below the bars. The air can be cut off from the furnace by a throttle valve, and its pressure varied by admitting more or less steam to the jet. The water is contained in a shallow trough moulded to fit the flue; its office is not so much to keep the bars cool as to prevent the twisting which takes place when they experience any great change of temperature. The level of the water is maintained by an external reservoir.

From 20 lb. to 30 lb. of fuel can be burned per hour per square foot of area of this furnace. There is no special economy resulting from the mode in which the material is burned, but the advantage is that fuels can be used which have very little market, and thus, while an equal quantity of combustible must be consumed, the cost is very much reduced. At Messrs. Donkin's works a comparative test has been made between an ordinary furnace using gas coke and a Perret furnace using coke dust, the former costing 17*s.* 6*d.* and the latter 5*s.* per ton. The expense of the coke was 10*s.* 8*d.* per week and of the dust 4*s.* 3½*d.*, for practically equal quantities of water evaporated. The coke evaporated 7·2 lb. of water per pound of fuel, and the dust 4·9 lb. A longer test of three months showed an outlay of 49*l.* for coke and 22*l.* for dust, or a saving of 55 per cent. for the latter.

There are 37 of these furnaces at work in France, 27 in Italy, and 56 in America, and it may confidently be expected that when they become known they will increase rapidly in this country. There are many places where pulverulent fuel is exceedingly cheap, and immense quantities of it are wasted because there is no convenient means of burning it. In London gas coke commands an exceptionally high price, as the stringency of the rules against emitting smoke creates a market for it, but there are districts where it is exceedingly cheap, and where the dust is difficult to sell at any price. In such places the cost of steam power with a Perret furnace would be very small, while the expense of altering a boiler grate to the new system is evidently a very small matter.

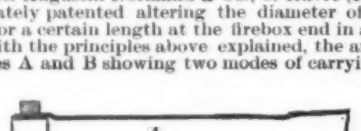
TUBULAR BOILERS.

IT is well known that in the smoke tubes of tubular steam boilers, the rate of production of steam, per unit of length, increases the nearer the part under consideration is to the firebox tube-plate. This fact was clearly demonstrated by the experiments of Petiet and others.

The steam thus produced at the ends of the tubes where they are inserted into the tube-plate, acting together with the steam supplied by the tube-plate itself, lessens the density of the water in contact with these surfaces, and the refrigerating power is reduced in proportion as the combustion is more active, the volume of water smaller, and the escape of steam more difficult. The result is that these surfaces become overheated and weakened, and expand excessively. The water may even possibly assume the spheroidal state. Leakages consequently often occur at the junction of the tubes with the tube-plate.

It would therefore be evidently advantageous to increase the volume of water and to facilitate the escape of the steam which is produced in this part of the boiler, provided that the section of the passage for the products of combustion, or heating gases, be not contracted in consequence. This may be done. The tubes of locomotive boilers are usually provided with iron or steel ferrules in the tube-sheet of the firebox. The internal diameter of the tubes may consequently be reduced to that of the inside of the ferrules without contracting the section of the passage for the gases. This reduction of diameter may be extended for a certain length, say from 1 ft. to 2 ft. for example, without lessening the evaporation, as the production of steam by a given heating surface, or, in other words, the quantity of heat transmitted, is proportional not only to the extent of this surface, but also to the refrigerating power of the liquid in contact with it. In the present instance, the heating surface is slightly reduced, at the contracted part of the tubes; but as the density of the mixture of steam and water surrounding it is at the same time increased, there are good reasons for assuming that the quantity of heat transferred is not lessened. On the contrary, if the diameter of the tubes were uniform throughout their length, and enlarged at the tube-plates only, an arrangement frequently adopted, the heating surface would be much reduced, and the speed of the heating gases increased, thereby producing a serious diminution in the production of steam.

Messrs. Augustin Normand & Co., of Havre (France), have lately patented altering the diameter of boiler tubes for a certain length at the firebox end in accordance with the principles above explained, the annexed sketches A and B showing two modes of carrying out



their plans. They have applied these improvements to the three last sea-going torpedo boats built by them for the French Government. The official trials consisted of three runs on the measured mile at the beginning, and three runs at the end for determining the advance of the boat per revolution, with a full speed run of two hours' duration inserted, no interruption being allowed between the different parts of the trial. A trial of this kind is certainly more severe and of longer duration than the ordinary three hours' run. The results were as follows.

Displacement at beginning of trial in English tons, 46·2 tons.

Number of boats.....	71	72	73
Dates of trials	June 13, 1885.	Aug. 14, 1885.	Aug. 24, 1885.
Mean speed during the two hours' run...knots	20·948	20·596	20·752
Mean revolutions per minute.....	310·48	306·86	309·65
Mean boiler pressure..lb.	127	129	129
Consumption of fuel (Anzin briquettes) per hour.... .. ..lb.	1120	1350	1350
Vacuum.....in.	27·6	28·9	27·2
Air pressure.....in.	3·3	3·5	3·5

None of the leakages in the fire tube-plates, which had been observed during the trials of the former boats, were experienced. The tubes are made of brass, 44 millimeters outside and 40 millimeters inside diameter, reduced to 39 and 35 millimeters respectively for a length of 300 millimeters (1 ft.) near the firebox tube-plate. The inside diameter of the ferrules is also 35 millimeters, so that the section of passage of gas is not reduced, although the thickness of the body of water, and the width of the longitudinal passages for the escape of steam between the tubes, is thus increased by 33 per cent. in the vicinity of the firebox tube-plate.

The results above recorded are of much interest, and we trust that further experiments will be made with Messrs. Normand's tubes on locomotive and on hard-fired marine boilers of the ordinary type.—*Engineering.*

COMPLETION OF THE CANADIAN PACIFIC RAILWAY.

IN the completion of the Canadian Pacific Railway, just taking place, has been brought to a successful close another one of those great enterprises for which Americans are famous. Says a correspondent of the *Tribune:* Surveys began in 1870, and a vast amount of information was collected. The government undertook the building of the proposed road, and by the end of 1880 had constructed 432 miles of track between Winnipeg and Lake Superior, 213 miles up the Frazer River in British Columbia, and some other portions. The management proved unsatisfactory, however, and in 1881 the whole work was turned over to a corporation called the Canadian Pacific Railway Company, to which were given 710 miles of completed road and attached property, $35,000,000 in cash, 25,000,000 acres of land, exemption from taxation or customs duties on construction materials, and various other privileges and immunities; in return for which it was to construct, equip, and operate a transcontinental line north of Lake Superior, within ten years. W. C. Van Horne, a resident of Milwaukee, who had large experience, was made general manager, and the work began.

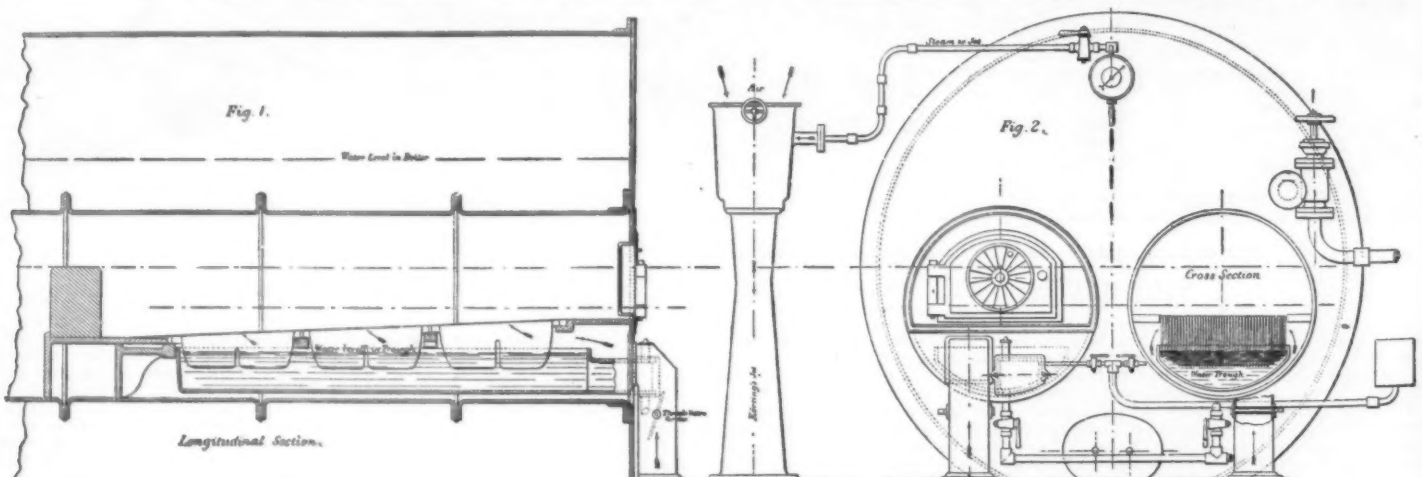
Never was a railway pushed forward so rapidly. Forty thousand men were at one time engaged all along the line, and half that number were almost continuously employed. In Ontario and Quebec old railways were bought and knit into the system. A new road was built from Montreal to Toronto via Ottawa, and a line of Clyde built steamers put upon the Great Lakes to make complete the route between Winnipeg and the sea. An army of engineers and laborers under the most admirable discipline, and aided by improved appliances, was mustered on the plains, and before the end of 1881 the main line had been carried to 185 miles west of Winnipeg. The next year it was advanced 418 miles further, and by the end of November, 1883, the track had reached the summit of the Rocky Mountains. The speed with which this was put down was wonderful. Scores of days together would show an average advance of three and three-quarter miles; while the total average between Winnipeg and the Rockies was over two and one-half miles for every working day.

Meanwhile, a great force of Chinese shovelers were pushing eastward in British Columbia, and there was no lack of activity in Ontario. The track already laid up the Ottawa was advanced beyond Lack Nippissing, and at the same time large bodies of men were landed along the northern shore of Lake Superior and began to work toward each other through the heavy forests, granite knolls, and dashing rivers that make up the scenery of that savage region. A large amount of work here—hundreds of miles of track—was accomplished amid the snows of a semi-arctic winter. In May of the present year the various sections were united, and a continuous track presented from the wharves at Quebec to the western side of the Rocky Mountains, twenty-five hundred miles. All that remained to open the line clear through to the Pacific was the crossing of three mountain ranges, but this of itself was a gigantic undertaking. The Rockies trend westward so rapidly that in British Columbia they are in the longitude of Salt Lake. There are three separate lines of mountains; easternmost, the Rockies, so called; next, an equally lofty range named Selkirk; third, the Gold Range. Between the Rockies and the Selkirks, near the boundary line, rises the great Columbia River. It flows northward vainly seeking escape, until it reaches the northern end of the Selkirks just above latitude 52°, when it sweeps around them, and begins to flow directly southward along their western flank. The engineers had, therefore, to carry their iron road over the Rockies, span the upper Columbia, surmount the Selkirks, cross the enlarged Columbia a second time, traverse the Gold Range, and meet the Pacific division at the Sushwap lakes. To-day a completed track stretches 3,100 miles from Quebec to Port Moody, besides some 1,500 miles of branches.

Now a few words, all from personal observation, as to what is to be seen along this new route. The appearance of eastern Canada is nowhere remarkable, but the equipment of the new line will attract attention. The parlor and dining and sleeping cars, of solid mahogany, are all made in Ohio, but the company builds its own locomotives and commoner cars. North of Lake Superior the country is wild in the extreme. Rugged forests stand upon rugged rocks. The many streams are full of cataracts, and boil and roar among ledges and bowlders. Between the Ottawa and the lake the track runs upon the low Laurentian watershed, and you may launch your canoe on one side and float to Hudson's Bay, or on the other for an exciting trip to Lake Superior, each way through a primeval wilderness abounding in fish and game and opportunities for adventure.

On Thunder Bay, behind the magnificent basaltic headland of Thunder Cape, is the flourishing port of Prince Arthur's Landing, and near it old Fort William, which began to be a trading post when the Sieur du Luth, in 1678, built a fort here for trading with the Sioux. Then comes that wonderful tangle of rivers, marshes, and lakes, hills of naked granite and nooks of forest, through which for two centuries the Indian trader and trapper, the French voyageur and red-skinned warrior, have been gliding in birch bark canoes on errands of peril and privation, glorified now and then by fabulous rewards. This is Keewaydin, "home of the northwest wind."

Four hundred miles west of Port Arthur we emerge



PERRET'S FURNACE FOR DUST FUEL.

upon the prairies of the Red River country, and, where the Red and the Assiniboine join, find a city of 30,000 people, covering what only ten years ago were the Indian camping grounds at the gates of Fort Garry. Winnipeg is to be to the Canadian Northwest what Chicago is to the Prairie States, or St. Paul to the upper Mississippi region, and its further growth will be rapid and sure. Five railways now center there, and it is thus the collecting and distributing point for all the great agricultural, fur-bearing, and fish-producing region of that northern interior.

The treeless plains which stretch through a thousand miles of open and level country west of the Red River are all cultivable, and for the first 500 miles are already dotted with villages and farmhouses. The higher and somewhat drier western half abounds in lakes, which break the monotony of the journey most pleasantly. The first glimpse of the mountains is got 100 miles away from their bases—a delicate crinkled line of white along the horizon, and at Calgarry they come into plain view. Calgarry is on the Bow River, which rushes down from the interior of the mountains to swell the great Saskatchewan. The Hudson's Bay Company had one of its most southerly posts there, and the mounted police force chose it for their chief station in that part of the world. Around this nucleus has sprung up a large town, which expects to be the Denver of that region, and will be supported by the cattle and sheep owners, whose increasing herds pasture between the foothills and the Saskatchewan everywhere south of the Red Deer River; and also by the varied industries of the mountains, in which mining, lumbering, and tourist-catching industries will soon begin to flourish.

Ah, those mountains! I know the Rockies "like a book," from the springs of the Columbia to the mouth of the Rio Colorado; and I vow there are none that surpass those that meet us after we roll through the gates of the Bow and begin the ascent of the Kicking Horse pass. At the head of the pass you are close beneath the sheer buttresses of Mount Stephen, crowned, six thousand feet overhead, by glittering masses of solid ice or of almost equally solid snow, and still there remain to astonish your eyes the loftier, even more abrupt, more glacier-studded, more gloriously savage Selkirks, which no man, white or red, had ever entered until the engineers fought their way across and drew the iron track after them. No person need go through the mountains without stopping, for hotels are building at several favorable points.

Beyond the mountains in British Columbia stretch rolling grasslands. This is primarily a cattle-raising region, yet large areas are suitable for farming, and producers will find an adequate market in the mining camps which before long will be scattered along the Gold Range and about the Big Bend of the Columbia, where the precious metals seem to be plentiful. When the Thompson River has been descended to its mouth, the road follows the Frazer down its resounding canons until the passage through the Cascade Mountains has been effected. Then, crossing over to Burrard's Inlet, the Pacific teminus is reached, whence a steamer may be taken to Victoria, or, by and by, to China and Japan.

The annual meeting of the Canadian Pacific Railway Company was held at Montreal, June 15. The report showed that of 65,000,000 dols. of stock, 40,000,000 dols. were held in England, 15,000,000 dols in Canada, and 10,000,000 dols. in the United States. The track will be completed by the end of September, there being only 203 miles in British Columbia yet to finish. At the beginning of next spring the company will have 4,000 miles of line in operation, with adequate terminal facilities. The floating indebtedness amounts to 6,895,401 dols., of which about 4,702,000 dols. has been created during the year by the purchase of rolling stock and the providing of elevating and terminal facilities, and on these a further expenditure of 5,045,000 dols. is to be made.

This will be provided for out of the sale of 15,000,000 dollars of bonds. The balance will suffice to complete the work in accordance with the terms of the contract, and the assets of the company will then exceed the liabilities by 110,000,000 dollars, estimating the value of its land grant at 2 dollars per acre. When the line is completed and worked throughout, the fixed charges will amount to 3,000,000 dollars annually. Last year the net earnings amounted to 1,191,900 dollars; and the first four months of this year showed an increase over the same period of last year by 992,104 dollars; and it is expected that there will be a net profit this year of 2,500,000 dollars. In the year following the completion of the line a gross traffic of 12,000,000 dollars is expected, and a net revenue of 3,500,000 dollars, or more than 500,000 dollars over all fixed charges. The report was adopted.

COMPOUND LOCOMOTIVE, WEBB'S PATENT, FOR THE COMPANHIA PAULISTA.

WE illustrate a Webb's patent three-cylinder compound engine, constructed by Messrs. Sharp, Stewart & Co. for the Paulista Railway. *The Engineer* says: This line is situated in the interior of the province of Sao Paulo, Brazil, commencing at the terminus of the Sao Paulo Railway, at Jundiahy; and as the coal for the use of the engines has to be imported from England and conveyed inland, it will be readily understood that economy of fuel is one of the first considerations. Mr. Hammond, the engineer of the line, therefore desired to make a trial of Webb's compound system; and the engine now illustrated was ordered, the contract being placed in the hands of Messrs. Sharp, Stewart, & Co., who had already supplied the company with bogie passenger engines which had given excellent results, duplication with these engines as far as possible being kept in view. In designing the compound engine, therefore, the builders retained as many as possible of the general features and details of the former engines, while introducing the three-cylinder arrangement, using the bogie as before, and duplicating the boiler and many other principal parts. As regards the compound arrangement, it is similar to that of the London and North-Western compound engines, which need hardly be again described. The leading dimensions are:

Gauge of line	5 ft. 3 in.
Cylinders, diameter of high pressure	0 ft. 11½ in.
Stroke of high pressure	1 ft. 10 in.
Diameter of low pressure	2 ft. 2 in.
Stroke of low pressure	2 ft. 0 in.
Wheels, diameter of driving	5 ft. 6⅛ in.
Diameter of bogie	3 ft. 1 in.
Wheel base fixed	7 ft. 9 in.
Wheel base total	20 ft. 3 in.
Boiler, length of barrel	10 ft. 4 in.
Diameter of barrel	3 ft. 10⅝ in.
Number of tubes, brass	156
Diameter of tubes outside	2 in.
Heating surface fire box and midfeather	99 sq. ft.
Tubes	870 sq. ft.
Total	969 sq. ft.
Grate area	16·75 sq. ft.

LOSS OF CAMPHOR BY VOLATILIZATION.—The range of the percentage of the loss in different samples is wide, the lowest being 11⅓ per cent., and the highest 84⅓ per cent., but the fact remains that gum camphor is very volatile, and while exposed to air under ordinary circumstances, suffers materially from loss by volatilization.

ORTHOCHROMATIC PHOTOGRAPHS.

WITHOUT going into the question of who first had the idea of making all the colors register their true gradation of light and shade upon the photographic plate, it certainly remains clear that Mr. Fred. E. Ives, of Philadelphia, was the first to realize and practically carry out a process to effect the object in view.

We have before us several examples of orthochromatic photography produced in Europe, and also some kindly sent to us by Mr. Ives at our request. From an examination of all these, we are satisfied that, until we can photograph in natural colors, these are the true, the coming photographs.

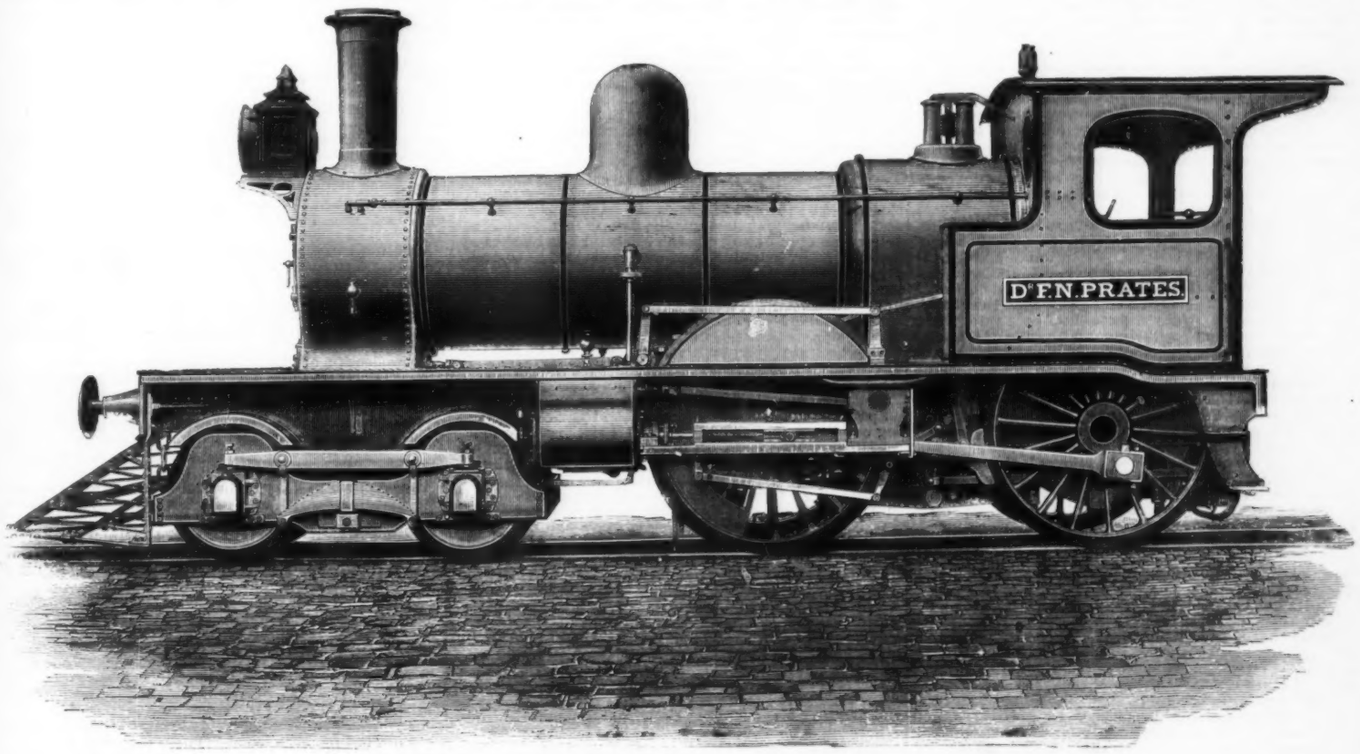
Mr. Ives makes the photographic plate sensitive to red and yellow light by adding chlorophyl, the green coloring matter of blue myrtle leaves, to the film. In Europe, on the other hand, Dr. Vogel uses a material which he calls azaline; while Schuman, Eder, and others use eosin, cyanin, and other dyestuffs. In all these cases—Ives as well as the others—a screen of yellow color interposed between the object and the sensitive plate is used to moderate the action of the blue and violet rays. And Ives' plates must be developed in subdued deep orange-green light.

In Europe there are several firms making orthochromatic plates. Lowy & Plener, of Vienna, are making them under the direction of Dr. Eder, and we have before us an illustration of the results obtained. The subject is an oil painting of the Madonna. The drapery and headdress in the original picture were dark blue, while the background was yellowish, shading to dark brown below. In the ordinary photograph we have the background and the figure blurred, the dark blue of the headdress and the yellow of the background behind it being very badly defined, while the whole picture is flat, the background and figure together. In the orthochromatic photograph, on the contrary, the whole picture is exceedingly lifelike, the shading wonderfully harmonious, and the figure stands out in fine relief.

In another set of pictures, we have illustrations of the work of plates made by Angerer & Szekely, of Vienna. In these a chromo-lithograph was taken as a subject. In the original picture we have a young girl in a blue dress, with brown hair, long terra-cotta gloves, and a bunch of reddish flowers in the neck. The background is bluish above, shading to green and brown foliage below. In the ordinary photograph of this picture, the hair, the flowers, the gloves, and the lower part of the background come out in harsh black patches entirely wanting in detail, while in the orthochromatic photograph every gradation of light and shade is well preserved, and the whole picture is harmonious and pleasing to the eye.

In a new book recently published in Germany, we have some examples of the work done with Dr. Vogel's azaline plates. In this case a golden shaded and purple fan, with a blue vase, have been taken as examples to show the results obtained with the plates. The picture produced by ordinary photography had the same characteristics as those mentioned above, while the orthochromatic photograph gives the colors in the correct relations.

In all the processes the examples of which we have noted above, we do not find the fine gradations of shade in all the colors which is to be noted in the examples that we have of the Ives chlorophyl process. In a picture of an autumn landscape that we have before us, the contrast between the two photographs of it—the ordinary and the orthochromatic—is really wonderful. In the ordinary photograph the richly covered foliage is one uniform mass of blackness, while in the orthochromatic photograph the lights and shades are beautifully preserved. In another example we have two photographs of a banknote, in which at first sight it would appear that two different notes have



IMPROVED COMPOUND LOCOMOTIVE—WEBB TYPE.

been photographed; while, on the contrary, the difference is caused by the inability of the ordinary photograph to reproduce the yellow and blue parts of the note in their correct value, and the faithful reproduction of these by the Ives process.

From what we have said, it is evident that this system of photography is the correct one, and will consequently be developed in the future. There is only one drawback to any of these methods at the present time, and that is the slow action of the plates. These films require a great many times the amount of exposure that we give to ordinary slow gelatine plates. But that this is only a temporary difficulty there can be no doubt, and we may any day hear of the production of orthochromatic photographs on plates that approach the rapidity of modern gelatine ones. As these plates are sensitive to light of all colors, they will have to be developed in a manner different from that now pursued.

Since such plates gives us pictures in the true relation of light and shade in colored objects, why should they not ultimately come into general use? To reproduce the fine gradations of light and shade in the pictures of Turner has tasked the skill of our finest engravers; while a photograph of our beautiful autumn landscapes is false in everything but the outlines. Orthochromatic photography will give us the means of overcoming these difficulties, and this is the method that will be used to produce the future photograph.—*Anthony's Photo. Bulletin.*

LANTERN SLIDES BY CONTACT PRINTING.

I PROPOSE to give full working details for the preparation of the emulsion and slides, because, while I believe it is capable of producing slides equal in quality to any other mode of preparation that an amateur, or one who does not make a specialty of such work, can produce, it is at the same time so simple that any ordinary amateur can obtain satisfactory results.

In the first place, no dark room is required, as the emulsion can be prepared by gaslight, and no more care is required than in the preparation and printing of albumenized paper. No washing of the emulsion is necessary; indeed, as far as the brilliancy of the slide is concerned, it is a disadvantage. One can see how the printing of the slide is going on as well as if it were an ordinary albumenized paper print; and the latter is the greatest gain of all, because we do away with the uncertainties of the blind processes, *i. e.*, any process in which light forms an invisible image requiring development. What I wanted to obtain was warm black or sepia tones.

To Mr. A. L. Henderson is due the credit of proposing the addition of one-third acetate to a third each of the citrate and chloride salts. From some experiments he exhibited, I at once thought he had found a process suitable for the production of lantern slides. After a few experiments, I decided to do away with the citrate because of the cold tones it gave, and because I could not obtain the same brilliancy and range of tones as when I used acetate and chloride of silver only.

So far, I have obtained the most satisfactory results by obtaining a fine sepia tone with the following formula. There is hardly anything, perhaps, in which the taste of different persons varies so much as in the tone of a lantern slide. For myself, I much prefer a warm sepia tone to the cold black or purple tones. But almost any color can be got from red through the brown shades to purple. The sodium chloride converts about eleven and a half of the twenty-eight grains of silver nitrate into silver chloride. I find by using a larger proportion of chloride there is far less brilliancy, and I did not want to use a larger amount of acetate than possible on account of it being a more unstable salt, and a large proportion might affect the keeping qualities.

I have not yet experimented in the direction of having an excess of silver nitrate in the film. It is quite possible that we might increase the speed of printing by so doing, and by adding a little citric acid make the plates keep well, the same as with albumenized paper. But we must remember that we have a quantity of nitrate of soda in the films, which probably acts the same as the free silver, because it was formerly used with silver nitrate to sensitize albumenized paper.

To prepare the emulsion put in a small jam-pot:

Gelatine	40 grains.
Acetate of soda	8 grains.
Water	2 ounces.

The gelatine is allowed to swell, and is then dissolved by standing the jam-pot in hot water.

In a test-tube or small bottle is dissolved:

Silver nitrate	28 grains in
Distilled water	1 ounce.

This is stood in the same hot water, so as to be about the same temperature.

When the gelatine is *thoroughly* dissolved, the nitrate of silver solution is poured into the jam-pot in a gentle stream, quickly stirring with a glass rod all the time.

Into another test tube put:

Chloride of sodium	4 grains.
Acetate of sodium	6 grains.
Water	1 ounce.

When dissolved, this is added to the above, the stirring being continued.

Two or three ounces of water is to be meanwhile poured on to one hundred and sixty grains of gelatine. In about a quarter of an hour the surplus water is poured off, and the gelatine added to the emulsion; the contents of the jam-pot are to be kept at about 100° Fahr., until the whole of the gelatine is dissolved. It is then put aside in the dark for twenty-four hours to set.

The details of filtering, coating the plates, printing, and toning, I will go into soon, and will now only refer to one or two points about the preparation of the emulsion. I generally use a Swiss gelatine, but Henrick's or any good gelatine will do as we l; indeed, this process does capitally for using up samples of gelatine which are not quite up to the mark for dry-plate work. As to the light, I prepare the emulsion and coat the plates by the light of a small paraffine lamp in perfect safety.

I will now describe the mode of preparing the plates, printing, etc. The jampot containing the emulsion is stood in hot water until the latter has thoroughly dissolved; half an ounce of alcohol and sufficient water is added to make the quantity up to six ounces.

It is then filtered. For filtering, I always use a small paraffine lamp glass with the bottom edge turned up (they can be bought at an oil shop for about twopence each). A piece of washleather or four or five thicknesses of fine muslin is tied on the bottom of the lamp glass. The dissolved emulsion is poured in, and by blowing in at the top of the glass the emulsion runs rapidly through, and is then ready for coating the plates.

To clean the plates, I scrub them with a nail-brush and water in which a little washing soda has been dissolved; they are then well rinsed in cold water, and stood up to dry in the racks. After they are dry, they are just dusted with a piece of clean washleather and stacked in a heap.

For coating such small plates, I think the best way is with a small silver teaspoon. A spoonful of the emulsion is poured on the center of the plate, and can be guided to the edges with the spoon if necessary.

For amateurs or those not accustomed to plate coating, this is an important point, besides a measured quantity being put on each plate. When the emulsion is poured from a small teapot or similar article, it has to be put down and a glass rod taken up. While looking after these things the emulsion is meanwhile cooling, and perhaps running off the edges of the plate, but with the spoon the eyes need not be taken from the pool of emulsion on the plate.

For leveling the plates after coating, I do not use a large glass or slate slab, but have some strips of plate-glass about two feet long and two and a half inches wide; these are stood in rows on a level table or board. Suitable strips of glass can be got very cheap at a glass-cutter's, because any odd sizes from his scrap heap will do. When a large flat slab is used, if any emulsion gets on the back of the plates, they stick to the slab, and in the dull light of the dark room, when coating rapid bromide plates, this sticking is a great nuisance, and makes one think, if not say, words that one does not find in a Sunday-school lesson-book.

With the strips of glass, the plates can be laid down on them without the emulsion running off the plates, and can be easily detached from them even if stuck with some emulsion on the backs.

The plates are put away to dry in the usual way. I never find it necessary to use heat when drying plates on a small scale. My drying-box is in a room at the top of the house, the fireplace of which I have closed up. The outlet of the drying-box goes into the chimney, and I get a capital draught. Of course I have to keep the window in the room closed when drying plates, to get all the draught through the drying box.

For these plates any one can easily make a temporary drying-box by standing the racks on a shelf in the fire-grate, and covering a thick cloth over the front of the fireplace in the same way as a sweep does when sweeping a chimney. Then place two or three little pieces of wood on the floor to form little inlets between them for the air to pass between the floor and the cloth; a piece of fine muslin thrown over the racks would keep any dust, etc., from the plates.

To print, the plates are put in a printing-frame against the negative the same as a piece of albumenized paper. One can judge how deep to print by opening one-half of the printing-frame back, and by looking down on the back of the transparency; when the whole of the high lights of the picture are just tinted, it will be printed deep enough.

I find that fuming the plates with ammonia is a great improvement in every way. I do this by standing a few of the plates against the sides of a small box. Then pour a few drops of ammonia on a piece of blotting paper, put it in the bottom of the box, which is closed for a short time, and the plates are then ready for printing.

The great difficulty I have found with these plates, until recently, has been with the toning. The action was not only slow, but I could not get the warm brown or sepia tones I was trying for. I tried a number of different toning formulas, but all had the same action, though some bleached more than others. At last it struck me that I had a slight excess of acetate of soda in the film, so I tried the gold alone, and then got the tones I wanted, and far more quickly. The formula was:

Chloride of gold	15 grains.
Water (distilled)	15 drachms,

as the stock solution.

In a clean developing dish I took of the:

Chloride of gold solution	8 minims.
Water	1 ounce.
Common whiting	2 or 3 grains.

The plate was put into this toning-bath, without washing, until the image had quite lost its red color, and was then well washed and put into a bath of:

Hyposulphite of soda	1 ounce,
Water	5 ounces,

for about fifteen minutes, and again well washed.

Lately I found I could tone the plates in about one-fifth of the time taken by the above bath, by adding acids to the gold before neutralizing with the whiting. The bath was made as follows:

Gold solution	8 minims.
Hydrochloric acid	2 "
Nitric acid	1 "
Water	1 ounce.
Whiting	2 or 3 grains.

This bath toned the plate very rapidly and equally, but I think it requires the plate to be rather more deeply printed than when the acids are not used. I have not had time to try any comparative test with prints from the same negative, as to which bath gives the best tones and results, and can only speak now as to the rapidity.

It is better not to print in direct sunlight if the sun is at all warm, as the warmth sometimes causes the films to stick slightly.

There are two uses for these plates, besides lantern slides and transparencies. By printing less deeply and backing with tinted or drawing paper (film to the paper), they do capitally for producing photo-crayons. But, for professional photographers, I believe their great use will be in the reproduction of negatives, as one can not only see how deep to print with both the transparency and the second negative, but parts can be shaded during printing to get details in other parts which may be too dense in the original negative.

It will be also seen, however, that any amount of "dodging" can be done. The transparency can be re-touched as required, any shadows which print too heavy can be reduced in the same way as too dense negatives are locally reduced. Then we can do any amount of double printing, printing in clouds, etc., on the transparency; the name of the view can be painted on it without having to reverse the letters. We can vignette or mask when printing from either the original negative or the transparency. In fact, we can build up, so to speak, the picture on the transparency as we require it, because be can see what we are doing. And when it is perfect, we have only to print by contact a second or any number of negatives from it, which negatives can be printed from on to paper without any trouble of vignetting, etc., for each separate print. And to my mind, Mr. Henderson's discovery of the use of acetate of silver with the chloride in the gelatine film for contact printing will lead to very important results, in the aid it will be, practically, to photographers in their every-day work.—*Herbert S. Starnes, in British Jour. of Photo.*

[Continued from SUPPLEMENT, No. 514, page 8209.]

THE PRESERVATION OF TIMBER.*

REPORT OF THE COMMITTEE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS ON THE PRESERVATION OF TIMBER, PRESENTED AND ACCEPTED AT THE ANNUAL CONVENTION, JUNE 25, 1885.

SELECTION OF PRESERVING PROCESS.

IN view of the differing cost of the various antiseptics used, and of the price of timber in this country, where it is still much cheaper than in Europe, we believe that the method to be selected for preserving wood (if any) depends almost wholly upon its proposed subsequent exposure, and that it has been a mistake hitherto to look to a single process for all purposes.

If the timber is to be exposed, in sea water, to the attacks of the *Teredo navalis* and *Limnoria terebrans*, there is but one antiseptic which can be used with our present knowledge. This is creosote, or "dead oil," and the amount of it necessary depends upon the activity of the *teredo*, or rather upon the length of time during the year when the temperature of the water renders them active.

In our northern harbors, probably ten to twelve pounds of creosote to the cubic foot of timber are sufficient, but in southern seas it is probably necessary to inject from fourteen to twenty pounds per cubic foot.

Whether it will pay to do this depends upon so many local circumstances in each case that this cannot well be discussed here. If the timber is to be exposed in a very wet situation, creosoting is also the best process to use. It will cost from ten dollars to twenty dollars per thousand feet, b. m., or thirty-five to sixty cents per tie.

The selection of the oil, as well as quantity, is of importance. It was formerly believed that the antiseptic properties of dead oil arose from the presence of carbolic and cresylic acids, but a very able paper by Mr. S. B. Boulton, the leading authority on creosoting in England, read before the British Institution of Civil Engineers in 1884, seems to establish the fact that the preserving properties of dead oil, aside from the mechanical effect in keeping out moisture, are chiefly due to "acridine," or one of the alkaloids or bases now known to exist in creosote oils.

If the exposure is to be that of a railroad tie, creosoting is doubtless the most perfect process to use; but in view of the expense, it may be preferable to use a cheaper process, dependent somewhat upon the location, as away from the seaboard creosote is not available, and transportation is expensive.

Sleepers of Baltic fir, unprepared, nine feet long and ten by five inches, generally cost, in England, about ninety cents each, unloaded, grooved, and piled; and creosoting adds about twenty-four cents to this. So that the sleeper costs about one dollar and fourteen cents ready to go into the track, and is there laid with a chair under the double-headed rail, so that the latter does not cut into the wood. These sleepers, therefore, last eighteen to twenty years, while in this country they would probably be cut into by our foot-rail in from twelve to sixteen years; and, moreover, as the first cost of our ties, of corresponding timber, say hemlock or mountain pine, is only from twenty-five to thirty-five cents, we cannot afford to spend an equal sum in preserving them; and creosoting is notoriously more expensive here than in England.

With our present knowledge, and as a result of this investigation, we believe that burnettizing is the advisable process to use for ties at present in this country. This, if well done (and it is nearly useless to do it otherwise), will cost twenty to twenty-five cents per tie, and a discussion of the economical results to be expected therefrom will be found in Appendix No. 17, this being a report made by Mr. Chanute to the New York, Lake Erie, and Western Railroad in 1883, which that company kindly allows to be published.

Good results may be accomplished with sulphate of copper, but not only does this salt render wood brittle (more so, it is believed, than chloride of zinc), but as the copper attacks iron vessels, its use necessitates preserving cylinders of copper, and requires an expensive plant.

The great defect of all mineral salts is that they are easily soluble in water, and so wash out in time, and leave the timber unprotected. Hence the many attempts to patent some method of retaining them in the wood. What these may be worth must be determined by time, but the desirable combination for this country would seem to be the impregnation of the inside of the tie with some metallic salt to poison the germs of decay, and a thin coat of creosote outside to repel the intrusion of moisture.

If the timber is to be exposed in a comparatively dry situation, as in bridges, a trestle, or a fence, the results of this investigation indicate that kyanizing is a good process to use. It does not seem to impair the strength of the timber as much as burnettizing, and the latter accordingly is not recommended for those parts of structures (chords, ties, etc.) which are to bear tensile strains.

* From the Transactions of the Society.

Kyanizing costs about $6 per 1,000 feet, b. m., and success with it cannot be expected unless the work be well done. Caution will need to be observed in carrying it on, as corrosive sublimate is a violent poison.

MODES OF APPLICATION.

The various modes of preserving wood which have been experimented with may be summarized as follows:

1st. Injecting in closed cylinders under pressure.
2d. Steeping or immersion.
3d. Boucherie process, hydraulic pressure to the log.
4th. Exposure to vapors.
5th. Absorption by capillary action.
6th. Inward insertion of powders or liquids.
7th. Charring. Application of heat.
8th. Painting.

The first three are the only ones which need concern us, and of these the first is on all accounts the best, most effective, and most expeditious. It is believed to be nearly impracticable to use on a commercial scale any of the other modes of application for the injection of antiseptics.

CONDITIONS OF SUCCESS.

It has already been stated that success in wood preservation has heretofore been the rule in Europe, and the exception in this country. This has chiefly resulted from the fact that, timber being cheap and interest high, it was generally more economical to let the wood rot than to go to the expense of doing the work well, and the business accordingly drifted mainly into the hands of designing men and quacks. The advancing price of timber, however, which has about doubled within the last twenty years, and the decline in the rate of interest, which has dropped about one-third within the same period of time, now make it practicable, and in many cases necessary, to preserve wood against decay in many parts of this country.

Your committee will, therefore, attempt to state the principal conditions to be observed to achieve success, so far as they have been disclosed by this investigation:

1. Select the appropriate process, in view of the subsequent intended exposure of the timber.

2. Select the more open-grained, porous, and sappy varieties of wood to operate upon.

Antiseptics penetrate but little into the dense structure of white oak, burr oak, and yellow or heart pine, and are of doubtful utility for white pine, chestnut, or spruce, while they readily impregnate and preserve the following varieties of wood:

Hemlock,	Black oak.
Sweet gum,	Red oak,
Mountain pine,	Gray oak,
Loblolly pine,	Water oak,
Beech,	Sour oak,
Poplar,	Cottonwood,
Ash,	Maple.

Mr. J. B. Francis found in burnettizing that white birch with the bark on was well preserved, while in hewed white birch the decay was complete, probably because of the difference in density and penetrability of the sap wood and the heart wood.

The experience of the English engineers is to the same effect, and they prefer to employ for creosoting the more open-grained kinds of wood, and sap wood rather than heart.

It will be found that there are great differences in the density of wood grown in various localities and sections of the country.

3. Operate upon the cheaper woods. Not only is the preserving effect less upon the more valuable kinds, but they are more durable naturally, and it is a question whether at present prices it will pay to prepare them against decay. The cheap woods, on the contrary, can be made to outlast the best woods in their natural state by a thorough artificial preparation.

For railroad ties it will be advisable to select the harder kinds of wood to guard them against cutting into by the rails, especially upon curves. Preservation, however, materially adds to the natural hardness of timber, and it is found to resist cutting by the rail, under ordinary traffic, from twelve to sixteen years.

4. Extract the sap and water, as far as practicable, before injecting the preservative. It is obvious that a liquid solution cannot be forced in unless there is a place for it, and yet most of the failures of valuable methods can be traced to neglect of this obvious requirement. Timber must be well seasoned either naturally or artificially before the antiseptic is injected, except in the case of the Boucherie process, which can only be applied to freshly cut logs.

The Europeans operate, as has been stated, upon timber which has been cut and seasoned six months or more, and hence they find little trouble in injecting the solutions. In this country we must operate chiefly upon green or freshly cut timber, and hence must resort to steaming, if we use the pressure method of injection. Very good results are accomplished by steaming, but the work must be well done, and at such heat and pressure as not to injure the fiber.

5. Put in enough of the antiseptic to accomplish the desired result, and make sure that its quality and strength are such as neither to injure the fiber of the wood nor to leave it unprotected.

6. After the wood is prepared, allow it to dry as much as practicable before using. Its durability will be materially increased by getting rid of surplus moisture.

7. Let there be no undue haste in carrying on the work. This is sure to result in unsatisfactory preparation.

8. In laying prepared ties or timber in the track, protect them from moisture or water, as far as practicable, by draining the road bed.

9. Contract with none but reliable parties. As an inspection subsequent to the doing of the work, short of chemical analysis, does not establish the fact whether it has been well done, and the results cannot be detected for some years, there will always be a great temptation to do bad or careless work under contracts. The safe course, therefore, for those who decide to have timber preserved is either:

A. To do the work themselves, under the supervision of experts;

B. To contract it at a sufficient price to honest and skillful parties, keeping an inspector at the works to note the daily working when the magnitude of the order will warrant it; or,

C. Contract the work on such terms that the profits shall depend upon the results accomplished in preserving the wood against decay.

WILL IT PAY?

The question as to whether it will pay to preserve timber against decay seems to have been answered very positively in the affirmative in Europe. There seems to be, indeed, no longer any question there about it; preservation is looked upon as quite a matter of course, and public works which fail to avail of it are alluded to as neglecting an important economy.*

In this country, preservation of wood (except in an experimental way) has been the rare exception, but the time has probably arrived when, in many sections, an economy of twenty to fifty per cent. a year can be obtained in the maintenance of timber structures and cross-ties, by preparing them artificially to resist decay, while in other sections timber is still too cheap to warrant spending money to preserve it.

This depends upon the price. Thus, where a white oak tie costs twenty-five cents and lasts eight years, if we spend twenty-five cents more in preparing it so that it will last sixteen years, we but double the life as well as the cost, and save only the expense of taking the old tie out and placing the new tie in the track at the end of the first eight years, if the price of ties in the mean while continues the same.

If, however, the oak tie costs seventy-five cents, and we can substitute a hemlock tie, which would unprepared last three and a half years, and cost thirty cents, and by preparing it extend its life to twelve years, at an additional cost of twenty-five cents, or even more, we then have a notable economy, both in first cost and in duration.

In the case of piles which are cut off by the *teredo* in one or two years, as occurs in our southern harbors, the case is plain. They must be creosoted, or great waste and increased expense will result. In cases where they last eight to ten years, as in some northern sections, it will depend partly upon the value of the structure which the piles sustain whether it will pay to creosote them or not.

In the case of bridges and trestles, much will depend upon the exposure and the cost of maintenance, as well as upon the proximate exhaustion of suitable timber in the vicinity, and upon contemplated permanent renewals, while in the case of buildings, platforms, floors, etc., the ordinary wear from traffic will also have to be taken into account.

The most important factor will be the exposure (wet or dry), and consequent rate of decay. Thus all brewers find it very economical to preserve their floors; and mills, bleacheries, dye houses, etc., largely resort to artificial preparation of timber because of their exposure to slopping of water, and consequent moisture in heated apartments.

The engineers and managers of the several works, therefore, will have to figure up for themselves, in view of the local circumstances of their case, and the present and prospective price of timber, whether the economy of artificial treatment is sufficiently attractive to induce them to resort to it.

The great consumers of timber are the railroads, and the managers of such enterprises have to be governed by a good many considerations, both of finance and of expediency, besides those of eventual economy.

Hitherto, aside from the past cheapness of timber, the principal objections to its preparation against decay have been the lack of information as to what results could be confidently expected, and the conflicting claims of the promoters of various modes of treatment, each of whom represented his process as absolutely the best under all circumstances.

The committee hopes that this report of the results of its investigations during the past five years will have done something toward removing the above mentioned obstacles to an important economy, but there still remains the objection that the results to be accomplished are somewhat remote, while the expenditure must be immediate.

Railroad managers naturally want to obtain immediate returns. They do not like to burden the revenues of the current year for the benefit of future administrations, and they are with reason jealous of every dollar that goes out now, even if it promises to save two or three dollars in the future; yet, now that close competition requires every possible economy to be availed of, that railroads must more largely depend upon saving money in their maintenance, in order to continue or to resume their dividends, and that companies in good standing can obtain new capital for expense-saving appliances at four and one half or five per cent. a year, the time has probably arrived, in view of advancing prices and scarcity of timber, when some leading railroads will take steps to preserve it.

Computations of the money saving to be effected will be found in Appendix No. 6 and in Appendix No. 17.

In the former, Privy Councilor Funk estimates that in 1878, out of sixty millions of sleepers on the German railroads, twenty-five millions were impregnated, and that, even with the extraordinary length of life stated for unprepared ties (13·6 years for oak and 6·1 for fir and pine), had the remaining thirty-five million of ties been impregnated, there would have been a resulting economy of about one million of dollars a year, or some thirty-three per cent. on the cost of renewals.

This estimate is understood as having resulted in a material extension of tie preserving in Germany, notwithstanding the fact that metallic ties have already been largely introduced in that country.

As regards the latter, a simple calculation shows that the time has not yet arrived when they can profitably be introduced in this country. They will cost, laid in the track, about $2.50 each, and were they to last forever (the estimated life in Germany is twenty to forty years), the interest on the cost, at five per cent., would be 12½ cents a year a tie, or more than the annual charge of an unprepared white oak tie, costing seventy-seven cents in the track, and lasting seven years.

If, instead of 13·6 years for oak, and 6·1 years for fir and pine, unprepared, which life is said to obtain in Germany (probably in consequence of more thoroughly drained and ballasted road beds than our own), we assume a life of eight years for oak and four years for mountain pine and hemlock, as in better accord with experience in this country, we shall have the following computations of economy, upon the basis of Councilor Funk's paper, when oak sells at 50 cents, and hemlock at 25 cents a tie:

UNPREPARED TIES.

	Annual Charge
15,000,000 oak, @ 50 c. = $7,500,000 ÷ 8.....	$937,500
20,000,000 hemlock, @ 25 c. = $5,000,000 ÷4..	1,250,000
	$2,187,500

If it costs 25 cents each to impregnate them, we then have for lives of 16 and 12 years:

PRESERVED TIES.

	Annual Charge.
15,000,000 oak, @ 75 c. = $11,250,000 ÷ 16.....	$703,125
20,000,000 hemlock, @ 50 c. = 10,000,000 ÷ 12.	833,333
	$1,536,458

Annual economy, $651,042.

When, however, the prices have advanced to 75 cents for the oak and 30 cents for the hemlock, we have, with the same life and cost of preparation, the following comparison:

UNPREPARED TIES.

	Annual Charge
15,000,000 oak, @ 75 c. = 11,250,000 ÷ 8.....	$1,406,250
20,000,000 hemlock, @ 30 c. = $6,000,000 ÷ 4.	1,500,000
	$2,906,250

PRESERVED TIES.

	Annual Charge.
15,000,000 oak, @ $1 = $15,000,000 ÷ 16.....	$937,500
20,000,000 hemlock, @ 55 c. = $11,000,000 ÷ 12.	916,667
	$1,854,167

Annual economy, $1,052,083.

This illustrates how the economy of preservation increases as the price of ties advances.

The above mode of calculation is not strictly accurate. It omits the interest account, which would increase the cost as against the prepared ties, and it also omits the cost of periodical renewals, which would increase the cost of the unprepared ties.

Various methods have been employed for computing the economy of renewable structures. Local conditions and considerations vary so much, and there are so many circumstances which will force themselves into the account, that it is, perhaps, not wise to state any very definite rule in the premises. Your committee submit, however, three methods for such calculations in the appendix.

Appendix No. 18 is an estimate of the economy of creosoting ties, by Mr. E. R. Andrews, of this committee. Appendix No. 19 is an estimate of what increased life is necessary in order to justify a certain rate of expenditure in preserving timber, by Mr. B. M. Harrod, also of this committee; and Appendix No. 20 contains a formula for estimating the economy of various kinds of ties, furnished to your committee by an expert in such matters, the late Mr. Ashbel Welch, then president of this society, and who thus renders a last service to the society which regrets him still.

Respectfully submitted.

O. CHANUTE.
B. M. HARROD,
G. BOUSCAREN,
E. R. ANDREWS,
E. W. BOWDITCH,
C. S. SMITH,
J. W. PUTNAM,
G. H. MENDELL,
FREDERIC GRAFF, *ex-officio*,
Committee on the Preservation of Timber.

* Funk's paper, Appendix No. 6. Discussion of Boulton, "The Antiseptic Treatment of Timber."

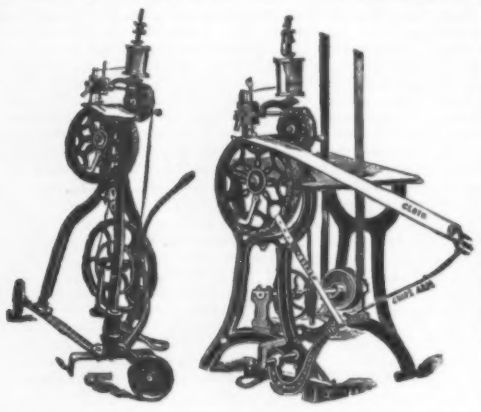
HOW TO RECOGNIZE GOOD WOOD.

THERE are certain appearances characteristic of good wood, to whatever class it belongs. In the same species of wood, that will, in general, be the strongest and most durable which has grown the slowest, as shown by the narrowness of the annular rings. The cellular tissue as seen in the medullary rays (when visible) should be hard and compact. The vascular or fibrous tissue should adhere firmly together, and should show no woolliness at a freshly cut surface; nor should it clog the teeth of the saw with loose fibers. If the wood is colored, darkness of color is in general a sign of strength and durability. The freshly cut surface should be firm and shining, and should have somewhat of a translucent appearance. In a wood of a given species, the heaviest specimens are generally the stronger and more lasting. Among the resinous woods, those having the least resin in their pores, and among the non-resinous woods, those having the least sap or gum in them, are generally the best. Timber should be free from such blemishes as "clefts," or cracks radiating from the center; "cupshakes," or cracks which partially separate one layer from another; "upsets," where the fibers have been crippled by compression; "wind galls," or wounds in a layer of wood which have been covered and concealed by the growth of subsequent layers over them, hollow, spongy places in the center, indicating the commencement of decay. It may be added that the microscope is of great value in testing the qualities of wood; its evidence is, indeed, decisive on this point. Samples and micro-photographs of bridge timbers which have proved faulty, but which a preliminary examination with the microscope would have thrown out, have been exhibited. The timber was from a railway bridge wrecked in 1879. Annular rings appeared about three times as far apart as they would be in good wood of a similar kind. The medullary rays were few in number and short in length, while in good wood they are of considerable length and so numerous that tangential sections present the appearance of a series of tubes seen endwise on a number of parallel chains. After once seeing and comparing samples of good wood, it is easy to recognize the difference with a pocket magnifying glass. The trunks and limbs of exogenous trees, as is well known, are built up of concentric rings or layers of woody fibers, which are held together by radial plates, acting like treenails in a boat's side. The rings, representing successive years' growth, are composed of tubes, the interstices of which are filled with cellulose. The slower the growth of the tree, the thinner these yearly rings, and the denser and harder the wood, other things being equal. Not only is the closeness of the texture an indication of the hardness and strength of the timber,

but the size, frequency, and distribution of the radial plates which bind the annual layers together may be taken as a sign of the character of the wood and its ability to resist strains, especially a breaking stress. In the strong kinds the concentric layers are close in texture and narrow in width, and the radial plates numerous, wide, long, and stout; while in poor stuff the opposite characteristics prevail. The practical application consists in having such enlarged photographic sections, longitudinal and transverse, of standard pieces of timber bearing a certain known maximum or minimum strain, and rejecting any piece which the assisted eye detects to have fewer rings per inch of diameter, fewer fibers, or fewer radial plates per square inch of section, or to use such pieces with a greater factor of safety. The advantage of the method is, that it allows all timber for important positions to be tested before being used.—*Ohio Lumber Journal.*

BLEACHWORKS MACHINERY.

THE series of operations conducted at a bleachworks necessarily comprises other processes than the simple chemical operation. Indeed, the amount of capital expended upon the simple bleaching process alone is but small, comparatively, a greater amount being represented by the accessories in the shape of calenders, mangles, and other machinery employed in the production of the numerous degrees and kinds of "finish." Thus the bleachworks is a very different concern from the old croft, and abounds in machinery, much of it of a very heavy and expensive nature, and which clearly may be held to form one of the textile series, for by it is treated in more or less degree every white piece of cotton cloth before being placed upon the market. Necessarily the first operation which has to be conducted after the various pieces of gray cloth have been properly assorted in their respective lots is to connect all the pieces of one lot together, and if the various lots are sufficiently small, several lots of equal quality and strength of texture by preference may form parts of one continuous length. We say of equal texture advisedly, for some sorts of cloth require a large number of repetitions of particular processes. This of course is rendered necessary by the greater thickness and strength of one cloth as compared with another, cloth of close texture not being so readily impregnated by the bleaching liquors as more open stuff. The stitching is usually performed in the gray room or in the singe-house, by preference the former, and a

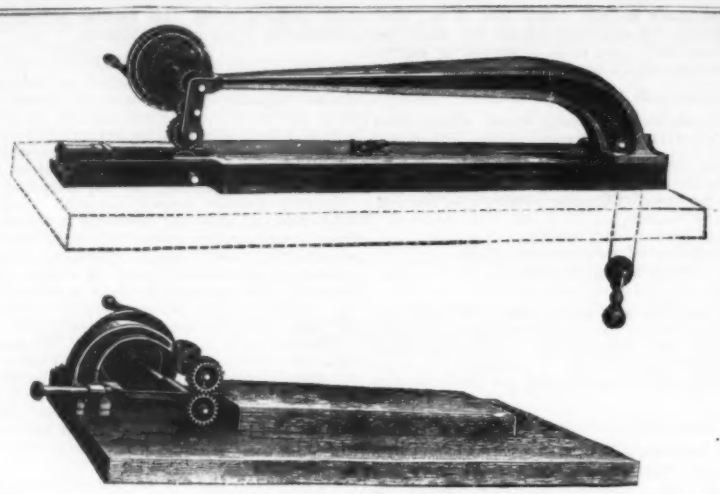


FIGS. 1B AND 1C.—BLEACHING MACHINERY.

type of machine largely employed is herewith illustrated (Fig. 1), as made by Messrs. Mather and Platt, of Salford, Manchester. It contains a long needle pointing between a pair of toothed wheels. The two pieces of cloth to be connected are laid together overlapping to a short distance; one edge is inserted between the toothed wheels, and the other edge is held by a clip sliding on the bed of the machine, and held fairly taut by the weight seen suspended below the table. On turning the handle of the machine, the cloth is forced by the toothed wheels upon a needle in the series of plaits or folds, and the thread thus passed back and forth through each piece of cloth. The thread is then drawn forward by hand, and the ends of the thread are left loose and hanging out to the extent of a few inches. Such a stitch, which can be of any degree of coarseness, depending on the size of the teeth, is very strong, and rarely fails in preserving the continuity of the band of cloth throughout the whole operation.

The tooth wheels are grooved round at the middle, the center of each tooth being cut away, so that the point of the needle is free to rest evenly between; otherwise, and failing the support, it would be readily broken. A high rate of work can be obtained on the machine by a skilled hand. The same machine constructed with a wooden bed is also largely used by calico printers in the bleaching department.

A rotary sewing machine on the chain stitch principle is made by Mr. W. Birch, Milton Street Ironworks, Broughton, Manchester. In this machine the cloth is drawn along beneath a rapidly reciprocating needle by a spike wheel. Fig. 1*b* shows this machine, which requires two attendents. In Fig. 1*c*, however, a modification is introduced in the shape of a guide arm, which holds the cloth taut while being being pulled through by the spiked wheel. In this illustration a strip of cloth is shown in process of being stitched. It is claimed for this machine that it keeps the cloth accurately to width, will sew either wet or dry, and, working with a continuous thread, leaves a short length of chain stitch band between each seam, which partially fastens the ends. This short band, of course, has to be divided by cutting. The machine when power driven is set in motion by pressure on a treadle. It should, however, be so adjusted as to keep constantly running at just such speed as will allow of the operator keeping it supplied with a gap of three or four inches between each seam, and the rate of speed must hence be proportioned to the skill of the operator. When stitchers are paid by the piece, it will often be found that they will run the machines excessively fast for a time, and keep up with the work at a considerable effort. They then, perhaps, remain idle for a long time. This practice is much to be deprecated, for not only is it bad for the machines, but it conduces to bad work and insecurity of the stitching. Now, a loose end in a bleach croft is always dangerous; it is still more so when not expected, and good stitching ought to be insisted on.



FIGS. 1 AND 1A.—BLEACHING MACHINERY.

The next process in bleaching is that known as singeing, which is designed to remove the woolly surface of the material formed by projecting fiber. The machine we illustrate at Fig. 2 is an improvement upon the old form of single-plate machine. In the improved machine the singe plates of copper are two in number, heated by one fire. The cloth is drawn through the machine and over the red hot plates at a fair rate of speed, depending upon the quality of the cloth, by means of the rollers visible in the front of our engraving, and which are driven by a small independent engine. The cloth passes first over the least heated plate of the two, and the bottom drawer roller works in a water trough, not merely to extinguish any possible spark which might come over, but as a first preparation to soaking out the size used in the process of manufacture. The frame seen above the singe plates is for the purpose of raising off the cloth from the plates in case of stoppage, so preventing burning. The pressure upon the plates by the cloth is regulated by this frame, and it is important that this be steady and regular, as if subjected to too

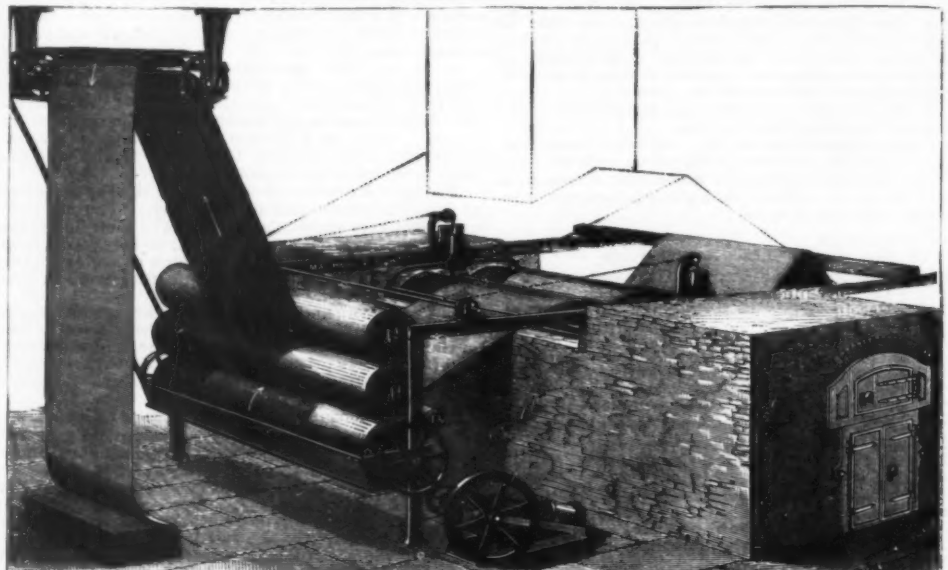


FIG. 2.—BLEACHING MACHINERY.

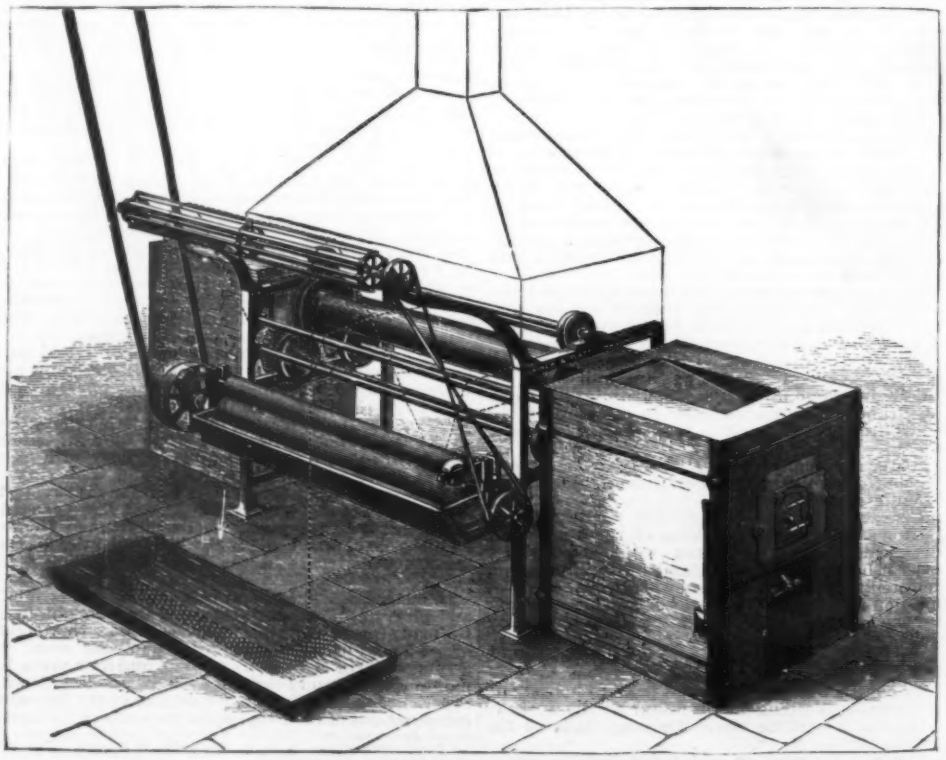


FIG. 3.—BLEACHING MACHINERY.

sudden strains, and the cloth becomes tight upon the plate, there is a liability to burning across. The operation of singeing is of course based on the fact that though it is easy to ignite an outstanding piece of fibrous stuff, a smooth surface about which flame cannot spread is not very readily set in a blaze. Thus in singeing it is only the small outstanding fibers which in the passing of the cloth over the plate are able to burn, the time of exposition not being sufficient to allow the heat to affect the body of the cloth. A smoke cowl is placed above the heated plates to draw off the fumes, which are very acrid and pungent. It is advisable that the singe-house be a fireproof structure, and a little isolated. After this process is complete, the cloth may be immediately passed to the liming keir, or it may be necessary to leave it for a time until a keir is open to receive it. Care should be taken that it be not left too long, as in its damp condition it is exceedingly liable to heat, and a salmon colored fungoid growth makes its appearance. Before liming, the cloth ought, however, to pass through a washing machine to remove the old size, which will come out the more readily if the cloth has lain in the damp and warm condition consequent on singeing for a few hours.

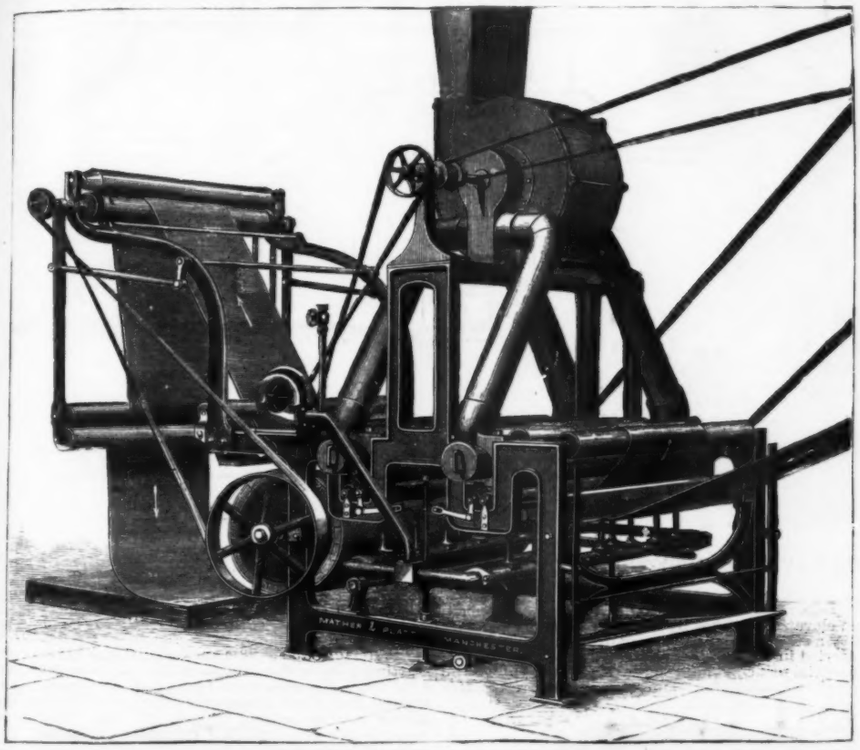


FIG. 4.—BLEACHING MACHINERY.

At Fig. 3 is shown another modification of singeing machine. In this case the plate is replaced by a roller of iron or copper. The fire passes through this tube, which revolves slowly on anti-friction bearing rollers, so that a freshly heated part keeps turning into contact with the cloth. The friction rollers are revolved by means of a worm and wheel visible in the illustration, and thus cause the singeing rollers resting upon them to revolve in turn. This roller machine is usually considered well adapted to velveteens and other pile goods, though it is also equally applicable to ordinary fabrics.

Some bleachers prefer gas to hot plates, and for their benefit the gas singeing frame, Fig. 4, is made. It is claimed that this machine is safer as regards risk of fire, and also more cleanly in its operation, than a plate machine. The cloth is drawn evenly through the machine in the usual way, and over a double row of burners, which are fed by a mixture of gas and air from a small fan visible on the side of the framing. Above each row of burners is a dust or smoke funnel, through which the fumes are drawn by the large fan above. The gas machine is equally serviceable to goods both gray, bleached, or dyed, and it appears practicable that a gas machine will leave the face of the cloth cleaner than will a plate machine, for the very friction on the plate must have a tendency to tear up loose fibers, while the gas flame effectually burns everything down to a level surface. In some machines a third row of burners is added, the machine, however, remaining *practically* the same in other respects. After singeing, the cloth is passed out on to keirs through a washing machine. The washing process is one of great importance, and is performed once at least between every other operation in the croft.—*Textile Manufacturer.*

IMPROVED HANK DYEING AND WRINGING MACHINE.

THE irresistible manner in which mechanical appliances, when once introduced into an industry, bear before them all manual processes that are capable of being supplanted by machinery (and we hardly know any that are not) is demonstrated once more by the remarkable manner in which the latter has won its way into dyeing and bleaching shops. The reason of this movement will be found in the greater economy and general perfection of the results attained by mechanical processes, as the factors engaged are usually uniform and measurable quantities, which is not perfectly so in the case of the use of manual means. It is owing to this that in places of any magnitude and having any quantity of work to do, machines such as those that are the subject of this notice are being generally adopted.

Mr. Robertshaw's invention consists of an improved mode of raising the fallers and continuing their revolution when they have carried the hanks out of the dye vat. In the older arrangement the hanks are kept upon the fallers, and naturally drain until the attendant can remove them. As the dye liquor drains off it first leaves the upper portion of the hanks, passing downward to the bottom, from which it falls back into the beck. It will be obvious from this description that the lower portion of the hank necessarily receives the heavier and more highly charged portion of the dye liquor, and remains saturated with it for a longer time. The result of this is that this portion gets more thoroughly saturated and more deeply dyed than the first portion. The hank therefore comes out of the process of an uneven shade, which is often the cause of complaint and dissatisfaction. To obviate these has been the endeavor of Mr. Robertshaw, which he saw would result from continuing the revolution of the fallers after they had risen from the beck. Our illustration, Fig. 1, shows the means by which he has accomplished the end aimed at. Nearly all the mechanism of the former pattern of the machine has been cleared away, including the counter weights, the racks, and the friction gearing. These have been substituted by the introduction of a bevel wheel, A, upon the first shaft which gears into another upon a short cross shaft. A swinging frame, B, is fitted upon this shaft, carrying the two intermediate wheels shown, the larger of which gears into the back wheel of the faller, C, the front wheel of which gears into the wheels upon the adjacent fallers, and through them actuates the series. The gearing is kept to its work by the loose hanger, D, at all stages of the traverse of the faller frame. By this simple and effective arrangement, the continuous revolution of the fallers is secured and shaded yarn avoided.

A very marked improvement in the means of raising the fallers has also been made. Instead of the friction plates, a small vertical shaft, E, and a worm have been introduced, the former of which is driven from the bevels upon the second shaft. As will be seen, this vertical shaft carries a wheel upon its foot which gears into a smaller one at the bottom of the worm, which has a square thread screw and is arranged vertically, working inside the pillar carrying the faller frame. By these means the fallers are quickly and steadily raised or lowered according to requirement. The action is perfectly automatic and self-stopping, the traversing arrangement being drawn out of gear when the frame has arrived at the top or bottom respectively by the projections, M N, acting upon the bowl, O, upon the clutch. This arrangement obviates the risk of breakages incident to driving by the friction appliances in use before; while being perfectly self-acting it releases the attention of the attendant for any other purpose. It may here again be observed that throughout this action the revolution of the fallers is maintained.

In the processes of dyeing it is well known that it is highly desirable that the workmen in many cases should not even touch anything made of iron, or it may lead to the materials in process of dyeing being spotted, as the oxide unavoidably taken upon the hands, when brought into contact with the materials of the dye bath, will combine with them, and often give very undesirable results. In order to prevent all possibility of this, Mr. Robertshaw has finished the ends of the fallers shown in Fig. 2 with brass, and covered the two starting lever handles with wood, and finished on the top with brass. This precludes the risk of spoiling work from that cause.

The wringing arrangement is retained as before, while the form of the hooks has been improved, in order to give greater facility for putting on and taking off the hanks.

Further information may be obtained on application to Mr. J. Robertshaw, Climax Works, Manchester.—*Textile Manufacturer.*

THE SILK INDUSTRY IN FRANCE.

U. S. CONSUL PEIXOTTO, consul at Lyons, reports to the State Department as follows:

The prices of silk have never been as low as at present; the prices, in fact, to which silk has fallen, necessarily carrying with them those of cocoons, the raw material, has rendered the industry so unprofitable as to have caused many hundreds of raisers and manufacturers to abandon it. Prices of mulberry leaves, the essential food of the worm, have also so greatly declined that millions of trees have been uprooted and the soil planted with other and more profitable growths. This fact holds true not only for France, but Spain and many districts in Italy.

It is questionable whether but for the introduction of labor saving machinery the once proud industry of silk would not be reduced to still inferior proportions. France at one time employed upward of one million hands, and produced over $100,000,000 of manufactured silk goods; scarcely more than half is the number and the sum of labor and product to-day.

One organzine silk of the first quality commanded in 1868 as high as 152 francs the kilogramme, or $29.33⅓; or, according to our method of calculation and purchase, more than $13 per pound. The same silk can now be bought for even less than $6 per pound. A grege silk, second quality, which cost in 1868 $11.66 the pound, can now be purchased for about $4.75.

The average production of silk which entered into the world's commerce from 1872 to 1882 was (counting all countries) 9,095,000 kilogrammes; the production has since decreased in all countries of the world.

The low prices of to-day are owing to the greatly diminished demand for silk dress goods and their being replaced by other tissues, principally those of wool and cotton, which have for several years back been in fashion and still continue in favor.

In this connection it may be interesting to notice the development and the amount of silk purchased and

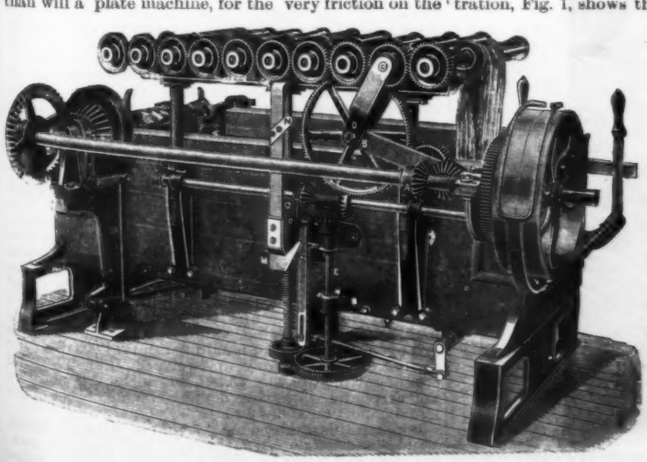


FIG. 1.

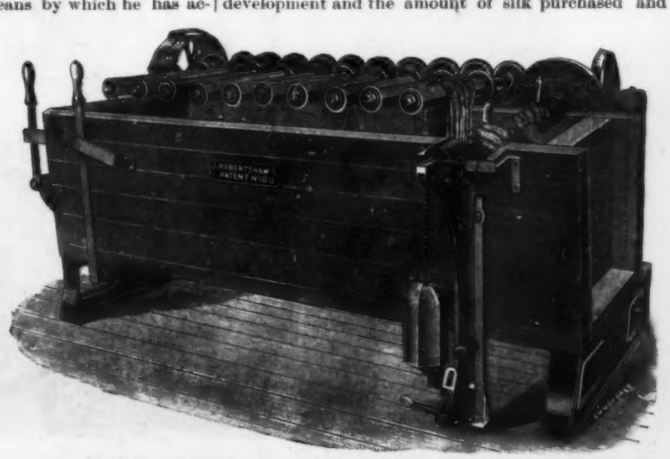


FIG. 2.

HANK DYEING AND WRINGING MACHINE.

consumed by American manufacturers in the short space of eight years.

	Bales.
1875	10,041
1876	11,288
1877	10,020
1878	13,699
1879	18,926
1880	20,899
1881	21,682
1882	21,889

It will thus be seen that the silk industry in the United States has more than doubled in eight years.

THE CEMENTS OF THE GATE OF FRANCE.

THE city of Grenoble is situated at the foot of Mount Rachais, from the base of which rise the abrupt rocks that are crowned by forts Rabot and Bastille. Above Fort Bastille rises Mount Jalla, which overlooks Grenoble, and is about 1,400 feet in height, and from which may be enjoyed a magnificent view of the Graisivaudan plain. This mountain contains the celebrated deposits of the Gate of France, which were discovered in 1842 by Col. Breton of the engineers, now on the retired list.

The Society of Cements of the Gate of France takes its name from one of the ancient gates of Grenoble, which was built under Lesdiguieres, and is situated upon the right bank of the Isere, to the northwest of the city. It includes three houses which are engaged in the manufacture and sale of cements; those of Dumolard & Viallet and of Arnaud, Vendre & Carriere, whose quarries are located on Mount Jalla, and of Dupuy de Bordes & Co., whose works are at Seyssins, four miles south of Grenoble. We shall occupy ourselves here with the first of these establishments, as this is the most important and the most interesting as regards exploitation.

Limestone of the Gate of France.—The cement stone of the Gate of France is extracted from a thick stratum of argillaceous and bituminous limestones, which are black in color and very finely grained, and which have a conchoidal cleavage. According to Mr. Lory, a noted geologist, this stratum is intimately connected with the base of cretaceous earth, and is remarkable for the homogeneousness and fineness of the clayey mixture which it contains in the proportion of about 24 per cent.

The principal deposit of the Gate of France makes an angle of about 15° with the vertical, and its thickness is 14¾ feet. To the right of this first deposit there are two others that have the same composition, but whose thickness is but from one to one and a half yards thick.

Further along we give the results yielded by an analysis of this limestone.

The Quarries.—Messrs. Dumolard and Viallet's quarries, which are located at the top of Mt. Jalla, comprise twenty superposed galleries, 11½ feet in height, separated by partitions of the same thickness (Figs. 1 and 2). The principal one of these is 1,300 feet above the furnace tops. The stones taken from the fourteen upper galleries are let down into the principal gallery through shafts in the secondary strata. Those from the five lower galleries are lifted to the same level by an elevator actuated by water in ordinary weather and by a steam engine in times of drought. The stones are carried in cars of 70 cubic feet capacity.

From the principal gallery the track runs along the side of the mountain for about 2,600 feet, and terminates on the brink of a precipice 920 feet in depth. Here the stones are placed in boxes, which are carried by an aerial automatic cable 2,000 feet in length (Fig. 3). On reaching the bottom, they are thrown down a vertical shaft that terminates in a horizontal gallery, through which they are carried by car directly to the platform of the furnaces.

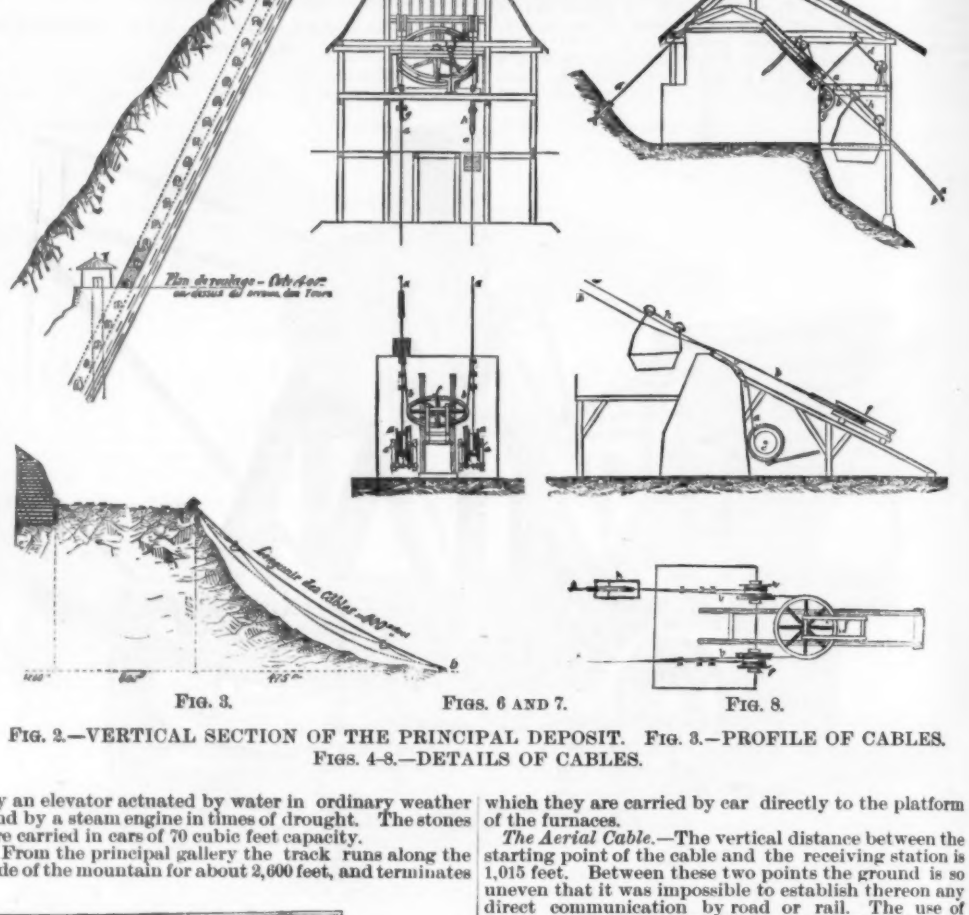


FIG. 2.—VERTICAL SECTION OF THE PRINCIPAL DEPOSIT. FIG. 3.—PROFILE OF CABLES. FIGS. 4-8.—DETAILS OF CABLES.

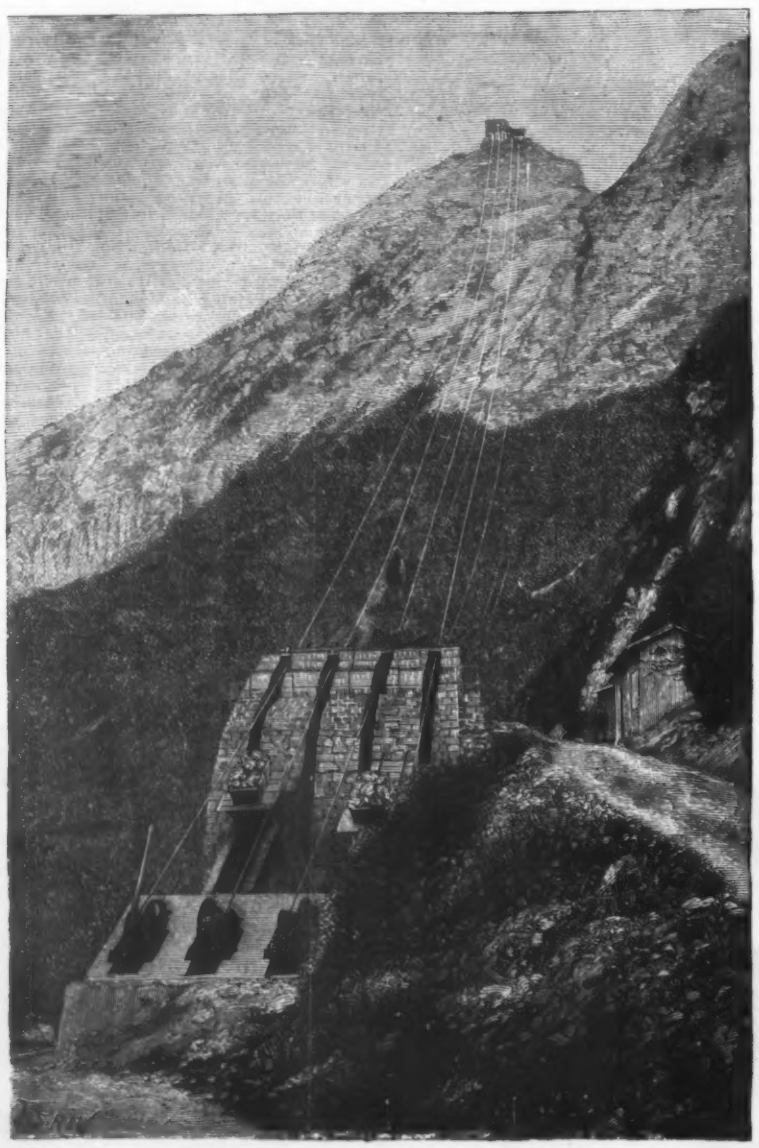


FIG. 1.—GENERAL VIEW OF THE AUTOMATIC AERIAL CABLE ON MT. JALLA.

The Aerial Cable.—The vertical distance between the starting point of the cable and the receiving station is 1,015 feet. Between these two points the ground is so uneven that it was impossible to establish thereon any direct communication by road or rail. The use of aerial cables was therefore naturally indicated. But such cables up to then had maximum lengths of but from 650 to 1,000 feet, and had carried loads that did not exceed 880 pounds, while at Mt. Jalla the length had to be 1,960 feet without any intermediate support. Besides this, since more than a hundred tons were daily moved, the loads carried could not be less than a ton. The two stations were connected by two steel cables 1¾ inch in diameter that served as a support for the boxes that carried the stones. These cables were anchored into the rock at the upper part, and were wound below over powerful drums that allowed them to be made taut (Figs. 3 to 8).

Originally, the two boxes were connected by a cable ¾ inch in diameter that wound round a brake pulley at the starting station, and which was of such a length that one of the boxes was at one station while the second was at the other. Under such circumstances, the full box, on descending, carried along the small cable and caused its empty mate to rise along the other supporting cable. The inconveniences of such a system were at once seen. The small cable, whose weight was 1,320 pounds, acted as a resistance during half the route, and as a motor during the other half. Besides, under the influence of its weight, it took on a pronounced and very variable curve, and owing to this there occurred great irregularities in the motion and sudden changes in the tension of the small cables, that gave rise to numerous accidents and a rapid wear of both them and the brake.

In order to remedy these inconveniences, the small cable was balanced by connecting the boxes at the lower part by another cable similar to the first, and passing over an inclined pulley located at the bottom station. In this cable, which then had a length of 3,900 feet, a regular tension was secured by mounting the lower pulley, *f*, upon a properly loaded four-wheeled tautening car, which ran up or down an inclined plane 65 feet in length, according as the tension increased or diminished (Figs. 7 and 8). In this way there was obtained a constant equilibrium of the two halves of the small cable, as well as an invariable tension. Besides, these modifications permitted of sending up a useful weight about four-tenths that of the descending load. In case the loads to be sent up possessed a greater weight than those to be sent down, the same system would be applicable by actuating the fixed pulley (which would then be located at the lower station) by means of a steam engine or some other motor.

The stationary cables are three yards apart and weigh 13,200 pounds. The driving cable weighs about 2,200 pounds. Each box, which has a movable bottom, has a capacity of 31¾ cubic feet. The load carried by each is 2,200 pounds. The pulleys, levers, bolts, cars, in a word, the entire metallic part, save the cables, weighs 18,700 pounds. The velocity is about 19 feet per second; it takes a minute and a half for the box to ascend; and the entire trip, including loading and unloading, takes three minutes. This arrangement permits of handling from 264,000 to 330,000 pounds of rock per day of twelve hours. The total cost of setting up was $3,100, not including masonry and carpenter work, thus making the mean cost of the metallic portion about 9 cents per pound.

Beneath this establishment is that of Messrs. Arnaud, Vendre and Carriere, comprising 18 galleries. On making their exit from the principal gallery, the cars follow

a track about 500 yards in length to an aerial cable arranged in about the same way as the one above described.

The Furnaces.—The furnaces are located at the foot of Mt. Jalla. They are 46 in number, are ovoid in shape, and have a mean capacity of 212 cubic feet. They are capable of being run continuously or at intervals.

The charges consist of alternate layers of stone and anthracite, in the proportion of about 550 pounds of the latter to 2,200 of the former for slow-setting cement, and 396 of coal dust to 2,200 of stone for quick-setting.

The duration of the burning is variable, and depends upon the dimensions of the furnace, the size of the materials, and the state of the atmosphere. It may be said, however, approximately, that a furnace with intermittent fire daily produces, per cubic foot of capacity, about two pounds of cement, while one with a continuous fire produces about five.

Upon emptying the furnace, two sorts of products are found that have sensibly the same chemical composition, and that present differences due merely to burning. These are (1) the overburned, vitrified, black stones, of great density, which yield the natural Portland cement of the Gate of France, and which are also used in the manufacture of artificial cement, and (2) the burned but not overheated stones of yellow color (and of a less density than the preceding), which yield the quick-setting cement of the Gate of France. The sorting of these stones can be readily effected by hand. Care is taken to leave a certain proportion of the overburned stones among those designed for the manufacture of quick-setting cement.

The Mills.—After the stones have been sorted, they are carried to the mills. The grinding is done by means of 24 pairs of horizontal stones actuated by powerful turbines, water-wheels, or steam engines, of a total power of 580 horses. These motors serve in addition to set in motion the crushing machines and the Archimedes screw that carries the finished cement to the storage silos. These latter are 24 in number, and have a total capacity of about 705,000 pounds.

The Society employs more than 500 persons, including miners, furnacemen, millers, machinists, stokers, coopers, teamsters, etc.

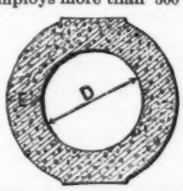


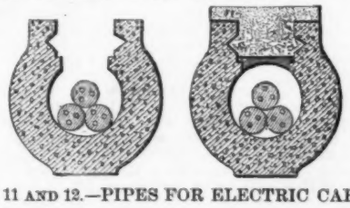
FIG. 10.—SECTION OF BETON WATER MAIN.

OF THE PRODUCTS AND THEIR APPLICATIONS.

The lime-rock of the Gate of France yields, upon analysis, the following results:

Clay	Silica	13·3	23·7
	Alumina	5·1	
	Peroxide of iron	2·6	
	Lime	1·7	
	Magnesia	1·0	
	Carbonate of lime		76·3
	Carbonate magnesia		
	Water, bitumen, etc.		
			100·0

The cements are of four kinds: (1) quick-setting; (2) semi-slow-setting natural Portland; (3) slow-setting artificial Portland; and (4) white Portland.



FIGS. 11 AND 12.—PIPES FOR ELECTRIC CABLES.

Quick-setting Cement.—This is obtained by a simple burning of the limestone. Upon analysis it gives the following results:

Clay	Silica	22·10	40.31
	Alumina	18·21	
	Oxide of iron		trace.
	Lime		55·98
	Magnesia		0·37
	Sulphate of lime		3·34
			100·00

This cement, when used in a pure state, sets in five minutes, and rapidly acquires a considerable resistance that increases with time. Among the special applications to which it has given rise, we may cite the following:

Beton Conduits for Water under Pressure (Fig. 10).—Proportions per cubic foot, 31 pounds of cement, ½ cubic foot of sand, and ¾ cubic foot of gravel.

The formula that gives the thickness of the conduit as a function of its internal diameter, and of the pressure, is $E = \frac{D\,H}{30}$; where E is the thickness expressed in inches, D the internal diameter in inches, and H the pressure of the water in inches.

Beton Conduits for Electric Cables.—The Society, in 1882, patented a system that consists in the use of beton pipes open longitudinally, assembled in lengths of about a yard in trenches, and hermetically closed with a mortar of cement after placing the cable in them (Figs. 11 and 12). In a metallic pipe, cables can only be introduced by traction, and at the risk of injuring them. The new system has been under trial at Toulouse since 1882, for telegraphs, and at Lyons for telephones, and has given satisfactory results. The Society is now at work on a system of double piping for electric light wires for the city of Saint Etienne (Fig. 13).

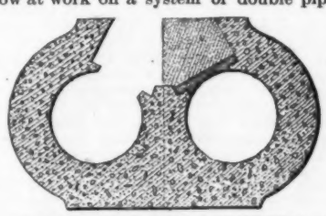


FIG. 13.—DOUBLE PIPE FOR ELECTRIC LIGHT CABLE.

Beton Drain Pipes.—These consist of two distinct parts (Fig. 14), viz., of a drain, B C D, which allows the water to pass, and of a collector, B A E D, which collects the water that has passed through the drain. This latter is composed of a beton made of 9 pounds of cement and 1 cubic foot of gravel per cubic foot, while the collector is made of a mixture of 31 pounds of cement, ½ cubic foot of sand, and ¾ cubic foot of gravel per cubic foot. As these two parts are moulded at the same time, they form a whole that presents great resistance.

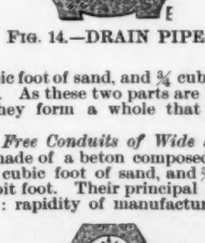


FIG. 14.—DRAIN PIPE.

Sewers and Free Conduits of Wide Section.—These conduits are made of a beton composed of 25 pounds of cement, ½ cubic foot of sand, and ¾ cubic foot of gravel per cubit foot. Their principal advantages are the following: rapidity of manufacture, regularity of form, suppression of coating, slight thickness, and quick hardening. The cement must set very quickly and be of superior quality, for otherwise these large masses of beton would run the risk of giving way under their own weight before they had set sufficiently to withstand the pressure.

FIG. 15.—AQUEDUCT OF THE CITY OF NICE.

The free aqueduct of the city of Nice (Fig. 15), the subways for the engineer corps at Grenoble (Fig. 16), the sewers of Bale, Annecy, Saint Chamond (Fig 17), etc., were all constructed by this process.

Tunnel Linings of Beton.—This system is especially advantageous as regards rapidity of execution; besides, in many cases, it is cheaper than rubber lining. If infiltration of water is not to be feared, it is only necessary to use a beton composed of one part of cement to seven of gravel.

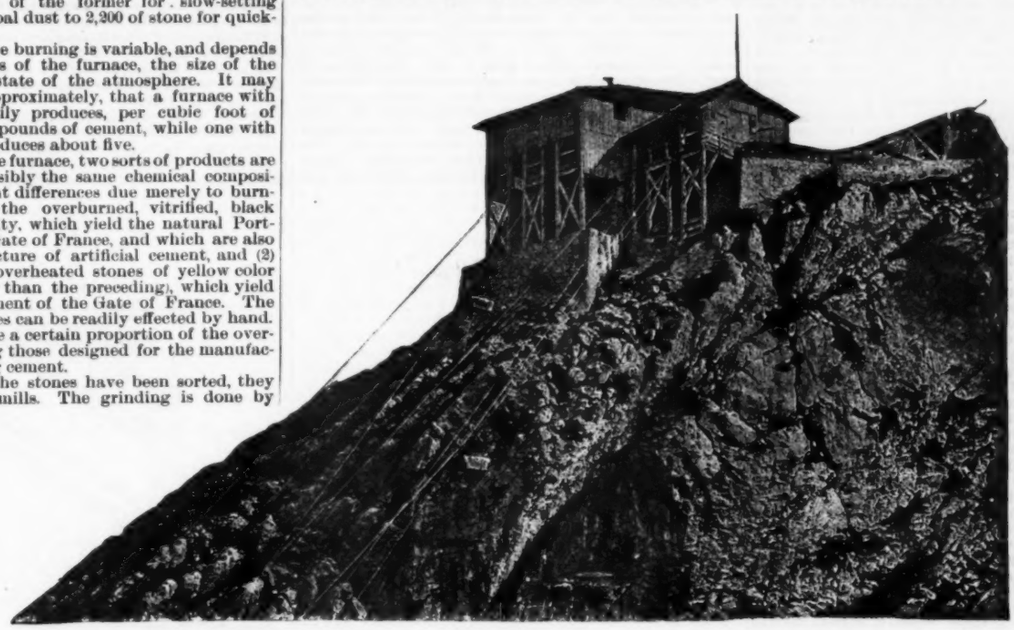


FIG. 9.—AUTOMATIC AERIAL CABLE—SHIPPING STATION.

In short, the quickness with which the cement sets, and its exceptional resistance to traction, which is obtained in a few days, give it an undoubted superiority in all work that requires first class materials, an adherence equal to that of the hardest stones, and quick execution.

In addition to its use in those important works that belong to the domain of the engineer, the quick-setting cement has applications that are of less consequence, but none the less interesting. Thus, for example, about twenty years ago a contractor conceived the idea of substituting cement posts for wooden ones for supporting vine trellises. On the line from Genoble to Lyons, at Saint Robert, there is an application of this system over an area of 40 acres, where about 40,000 of these posts have been set up.

FIG. 16.—SUBWAY.

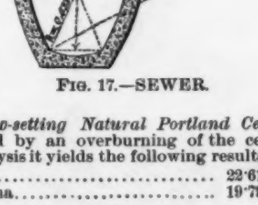


FIG. 17.—SEWER.

Semi-slow-setting Natural Portland Cement.—This is obtained by an overburning of the cement rock. Upon analysis it yields the following results:

Silica	22·61	42·40
Alumina	19·79	
Lime		51·63
Magnesia		0·37
Sulphate of lime		5·60
		100·00

FIG. 18.—TUNNEL LINING.

This cement in a pure state sets in 30 minutes, and in a short time acquires a greater resistance to traction than

that possessed by the quick-setting sort. Yet the last named is preferable in all work that requires rapidity of execution and mounding, such as water-mains under pressure, etc.

In order to retard the setting in hot weather, the quick-setting cement is sometimes mixed in certain proportions with the natural Portland. The resistance to traction in such a case is about midway between what would have been obtained separately with each of these products. This experimental fact demonstrates the erroneousness of the opinion that in a mixture of cements each behaves as if it were alone. Were such the case, the setting of the quick cement would be interfered with by that of the slow, and there would result a disintegration of the mass; that is to say, the final product would be analogous to that obtained by an inexperienced workman who continued to temper and disturb the cement while setting. Numerous experiments, on the contrary, have proved that two cements mixed with water behave like a new product that takes its properties from each of the elements that compose it.

A mixture of quick and natural Portland cements much facilitates the moulding of artificial stone, and the edges come out sharper, and the surfaces are more perfect. This line of manufacture has assumed quite extensive properties in the region of Dauphine, where such stones are now used as a substitute for dressed stone in a large number of constructions.

The natural Portland cement is much employed for lining gasometers, water reservoirs, etc. The rapidity with which the quick cement sets would not permit of its being laboriously spread over wide surfaces; and a slow-setting cement like the natural Portland, on the contrary, would be of difficult application to vertical surfaces or to the intrados of vaults.

This slow-setting natural cement is likewise employed for vaults upon T-irons, which are perfectly adapted for decorations in relief moulded in a piece with the vault, upon the intrados. Work of this kind, among others, has been done by the Society for the Direction d'Artillerie of Clermont-Ferrand.

Engine frames made of natural Portland beton offer all the advantages of very strong monoliths.

Slow-setting Artificial Portland Cement.—This cement, used in a pure state, sets in 3 hours, and is therefore of easy application, even by inexperienced workmen. It has about the same chemical composition as the artificial cements of Boulogne and England, as seen from the following table, where I. stands for the artificial Portland and II. for seven typical Boulogne and English Portland cements:

	I.	II.
Silica	25·20	24·1
Alumina and oxide of iron	11·40	10·3
Total lime	56·10	61·4
Magnesia	2·40	0·5
Sulphuric acid, alkali, water, and bodies not analyzed	4·90	3·7
	100·00	100·00

This product is much employed for making sidewalks, flagging, mosaics, etc. Streets and causeways made of beton and artificial cement mortar give very good results. There are numerous examples of them in the city of Grenoble, where the experiments date back about fifteen years. The wear is less than in ordinary paved ways, there is no noise from the passing carriages and carts, the keeping in repair is easy, and the heat of summer and frost of winter have no action.

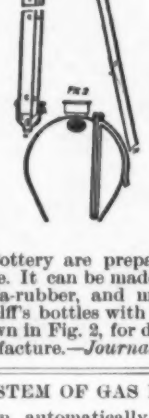
As it takes about a month for the artificial Portland mortar to thoroughly harden, the flagging made *in situ* can be replaced by that made somewhere else, in case it is to be laid in a street in which there is so much passing that it cannot be closed for so long a time. Work of this kind has been done by the Society for the Direction d'Artillerie of Clermont-Ferrand, at the forts in the environs of Belfort, in the cavalry stables at Montauban, in the different streets of Grenoble, etc.

This artificial cement is likewise employed in the construction of walls, in the proportion of one part of cement to seven of gravel. The strength of this beton permits of the thickness usually given to masonry being reduced one-half.

Among the other special applications of this product, we may cite the following: mouldings in beton for monolith bridges, for the battlements of walls, artificial blocks for jetties, etc.—*Le Genie Civil.*

A NEW SIPHON OPERATED BY BLOWING.

BODE & WIMPF have designed a new kind of siphon, which is of great use in siphoning off acid, caustic, or poisonous liquids. Its special feature is due to the fact that it is not set by suction, but by blowing, so that the liquid to be siphoned off can never get into the mouth. Fig. 1 represents the construction. The tube, D, is surrounded by a wider one, C, closed at the top, and provided with a ball valve, B, at the end, E. On putting the apparatus into a liquid, the ball valve is raised, and the tubes, C and D, are filled to the height of the surrounding liquor. If now air be blown into the tube, H, the valve is closed, and the liquid, being driven from C into D and F, sets the siphon to work. The blowing is then discontinued, and H closed. If it be desired to interrupt the flow, it is only necessary to blow again a little stronger through H. The valve, B, is now pressed into its seat, and no liquor being able to enter the siphon, it empties itself. The siphon need never be removed from the liquid, either at the start or at the end. C. Gerhard, of Bonn, and



the Moncheberg Pottery are prepared to supply the syphon to the trade. It can be made of glass, earthenware, ebonite, India-rubber, and metal. It is also intended to fit Woulff's bottles with this siphoning arrangement, as shown in Fig. 2, for drawing off acids in the course of manufacture.—*Journal Chem. Ind.*

COZE'S SYSTEM OF GAS RETORTS.

EXPERIMENTS in automatically charging retorts have often been made in gas works, but the methods hitherto devised have been either too costly or too complicated. Instead of seeking a solution of the problem in the use of mechanical apparatus, Mr. A. Coze has thought it would be easier to give the retorts an inclination such as to cause a natural fall of the coal from the upper end, and produce a uniform distribution thereof throughout its entire length.

In the annexed figure is shown an application of this idea to a seven retort furnace. In order to avoid certain difficulties of construction that presented themselves, an arrangement has been adopted by means of which the contents of a car can be dumped directly into chutes connected with the retorts, whatever be the height and position of the latter in the furnace. The section here shown will permit the general arrangement to be understood, although the details may vary according to the number of retorts. These latter have an inclination that corresponds nearly to the sliding limit of coal. Experiment has shown that the angle should be 29°. The extremity opposite the head of each retort is provided with a chute, which rises vertically to the exterior of the furnace, where it is closed by a cap. The mouths of all these chutes are on the same level and in a single row, so that it takes but one track to charge all the retorts. The elbow in each chute follows the prolongation of the retort for a certain length, and consequently the shock produced by the fall of the coal in the elbow, aided by the slope, brings about a proper distribution of the coal into a layer of uniform thickness. The result is that the upper portion of the coal forms a surface whose plane is parallel with the bottom of the retort. This condition is the most favorable one for a perfect distillation, since it provides sufficient space to permit of a free disengagement of the gas. In a word, the distillation proceeds just as in ordinary retorts, while the charging of such retort is instantaneous.

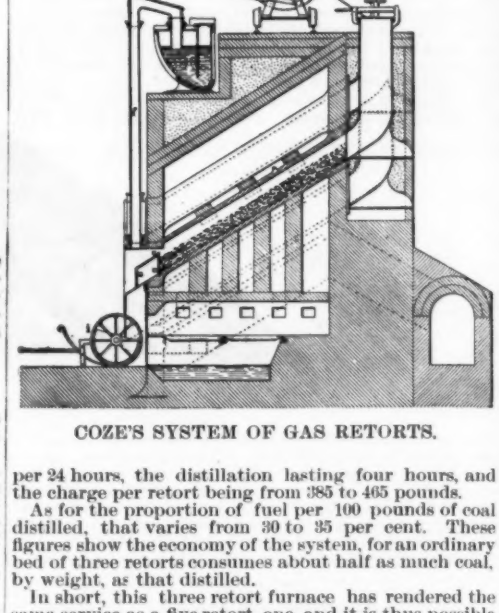
The chutes are surrounded by sand, in order to keep their temperature at such a point as to prevent condensation.

The head of the retorts is of the usual form, and the coal is prevented from falling out by a movable plate, *e e*. The hydraulic main and pipe, *f*, offer no peculiarity. In the case of two furnaces standing back to back, a single track located between the two rows of chutes does duty for both.

This system of retorts does not necessitate a peculiar form of furnace.

In order to clean the retorts, it is only necessary to slide a T-shaped tool in between the bottom and the coke to cause the latter to fall unbroken into the hand barrow, *i*. The discharge is instantaneous.

Mr. Coze's system has been submitted to trial for several months in a furnace of three retorts, and has from the beginning given satisfactory results. The production of gas is, on an average, 31,780 cubic feet



COZE'S SYSTEM OF GAS RETORTS.

per 24 hours, the distillation lasting four hours, and the charge per retort being from 385 to 465 pounds.

As for the proportion of fuel per 100 pounds of coal distilled, that varies from 30 to 35 per cent. These figures show the economy of the system, for an ordinary bed of three retorts consumes about half as much coal, by weight, as that distilled.

In short, this three retort furnace has rendered the same service as a five retort one, and it is thus possible to increase the production while at the same time reducing the labor. The advantages of this mode of charging retorts will be especially appreciated in large works. In consequence of the rapidity with which the maneuvers are effected, and the complete utilization of the surface of the retorts, it is possible to notably increase the nominal charge of the latter, and to increase the production of the furnace, and consequently reduce the cost of manufacture.—*Revue Industrielle.*

DEVELOPMENT OF HYDROCYANIC ACID IN LINSEED MEAL INFUSIONS.

IN all the literature of flaxseed which was accessible to us, we find no mention of the occurrence or development of Hcy in treating the seed or meal with water.

The analyses published in chemical works and in the commentaries to the various pharmacopœias contain no allusion to such an ingredient. Its presence was suspected by one of us about a year ago, owing to the characteristic odor which arose from a poultice prepared from the meal. An investigation was determined upon, but, owing to pressure of other matters, was dropped for the time. Recently the occasion was again presented for using the meal in form of a poultice and an examination promptly instituted.

A preliminary test with about four ounces of the meal strengthened our suspicions. The operation, which was undertaken mainly to decide upon the advisability of proceeding further, was simple enough. A hot soup plate containing water to receive the meal, formed the body of an extempore still. The condenser consisted of an evaporating dish, cooled on ice.

A space about four inches in diameter in its center, had been smeared lightly with strong solution of pure potassium hydrate. As the steam arose from the porridge, it condensed on the interior of the evaporating dish, which had been inverted over the soup plate. If any Hcy were present, it would of course be retained by the potassium hydrate as a cyanide. After the lapse of three minutes, sufficient vapor had condensed for testing. On rinsing with a little distilled water, treating with a mixture of ferrous sulphate and ferric chloride, afterward with hydrochloric acid and warming, an insoluble precipitate (Prussian blue) remained, appearing greenish while finely suspended, but assuming a blue color afterward as it separated. In order to put the results beyond the reach of controversy, by employing a meal known to be pure, we ground up several pounds of the whole seed ourselves, and submitted this to further examination.

1. To a portion of the meal was added sufficient warm water to form a porridge. On allowing this to stand in a covered beaker glass, a decided reaction was obtained with the guaiac-copper test. A strip of white filtering paper was moistened with a tincture of guaiac (4 per cent. resin in 94 per cent. alcohol), allowed to dry, and then wetted with an aqueous solution of cupric sulphate (1 to 400, Pagenstecher and Schoenbein's test), then exposed to the atmosphere in the beaker glass. A strong blue coloration ensued at once.

2. Four ounces of the meal with eight ounces of water were introduced into a glass retort, allowed to macerate for a while, then heated in a water bath (to about 80° C.). The receiver in which the vapors were condensed

FIG. 19.—AUTOMATIC AERIAL CABLE—RECEIVING STATION.

contained a 1 per cent. solution of potassium hydrate in 94 per cent. alcohol. The product obtained by the admixture of the distillate with the alcoholic potassa was treated with an aqueous solution of ferric acid (1 to 250) and boiled. The dark red coloration due to formation of potassium picrocyanate occurred immediately. This test (C. D. Braun) is exceedingly delicate.

3. Two ounces of the meal with eight ounces of water were distilled as in 2, the vapors being received in an aqueous solution of potassium hydrate.

On treating this with ferrous sulphate and ferric chloride, as in the preliminary test, a precipitate of Prussian blue separated in the course of half an hour.

4. Two ounces more of the meal were treated as in 2, the receiver containing distilled water. The product was added to a solution of iodized starch. After lapse of fifteen minutes, complete discoloration ensued (Schoenbein's test).

5. Two ounces of the meal were again treated as in 3, with aqueous potassium hydrate in the receiver. To the product was added a few drops of yellow ammonium sulphide and a little ammonia water. The liquid was next warmed in a porcelain dish, with renewal of the evaporating water, until the excess of ammonium sulphide was entirely volatilized. After acidulating with hydrochloric acid, the addition of ferric chloride caused a decided blood-red coloration (Liebig's test), due to ferric sulphocyanide.

The above results led us to assume that amygdalin might be present in linseed, while the following would warrant such a belief; but we prefer to reserve for a further examination the identification of the substances present which develop the Hcy. Another portion of the meal was exhausted of oil by percolation with petroleum benzin. After drying, about four ounces were exhausted by repeated additions of boiling alcohol. The extract was evaporated to a sirupy consistence, and subjected to several tests.

7. A part of this extract was diluted with water, and mixed with an emulsion of sweet almonds. Hcy was developed after standing a sufficient time, plainly perceptible after several hours, very prominent after twelve hours.

8. Another portion of the previously dried alcoholic extract dissolved in water, to which was added an infusion prepared from the residue of the same extraction (including the meal), failed to develop any odor indicating the presence of Hcy. This was expected, as Liebig states that in the extraction of bitter almonds by boiling alcohol the emulsion or sinaptase is rendered inert.

INCIDENTAL RESULTS.

An infusion of whole seed in cold water after lapse of several hours develops a plainly perceptible odor of Hcy. This odor is intensified by standing, especially after the seeds burst their integuments from swelling, and the water has access to the interior. An infusion made from whole seed with boiling water, as directed by the Br. Pharm., does not develop any Hcy within the time given for its completion (4 hours). After standing twenty-four hours, a very faint odor is perceptible. This leads to the conclusion that the ferment concerned in the production of the Hcy is coagulable by heat.

H. F. MEIER.
JOHN MEYER.

HYDROCHLORATE OF COCAINE.*

By Dr. SQUIBB.

A FEW months of additional experience with the process given for this salt in a previous paper has developed some improvements in the details of the process which are worth adding, because they overcome some of the difficulties mentioned as incidental to the process as there given.

The new process for extraction of the cinchona alkaloids by the use of kerosene was tried, but its inferior capacity as a solvent for cocaine and some other disadvantages seemed to overbalance its cheapness in comparison with alcohol and ether, unless the scale of operations was much larger than is likely to be required in the case of cocaine. If cocaine was to be used in the near future in one-thousandth part the quantity of the cinchona alkaloids, the much larger special apparatus required for the use of kerosene would doubtless be justified. But so long as the uses of cocaine are as limited as they are likely to be, alcohol and ether appear to the writer to be the best solvents so far, and hardly anything better can be imagined if alcohol and ether were once freed from the enormous spirit tax.

The first improvement made in the writer's process was to have the coca in much finer powder than was at first used. It is a difficult substance to exhaust thoroughly, and there is much difficulty in knowing when it is exhausted. Larger and larger yields were obtained as the powder was made finer and more menstruum used, until the maximum seems to have been reached with a powder through a sieve of sixty meshes to the linear inch instead of twenty, and menstruum to the amount of six times the weight of the powder instead of five times, and this when the great advantage is taken of repercolation.

The small proportion of about 1 part acid in 583 parts of the first portion of the menstruum, or 0·17 per cent., still seems to be a great advantage to the process, but there is no apparent advantage in reducing the proportion below this. And hydrochloric acid specific gravity 1·16 in double quantity may be substituted for sulphuric acid.

When all the alcohol has been distilled off, it is a very considerable improvement to add to the extract, while hot, about one-tenth of the weight of the coca represented in the extract, of water containing about 2 per cent. of acid. This is transferred to one or more bottles, which are only half filled, and when the liquid and apparatus are cold, the still is rinsed clean with two or three applications of ether in small quantities, the ethereal solution or washings being added to the contents of the bottles. Instead of attempting to wash the salt of the alkaloid out of this clotted mass of resinous extractive by water, which is very difficult to do, stronger ether is added to the mixture to the amount of about one-twentieth of the weight of the coca represented in the process. This at once dissolves all the chlorophyl and resinous extractive, and allows the acidulated water to be brought in better contact for the washing out of the alkaloid salt, which is insoluble in ether. The watery solution is then separated, and the ethereal residue is washed twice with fresh portions of the weak acid in small quantity, the washings being added to the first watery solution. The ethereal extractive is then free from alkaloid, and is set aside until the ether can be recovered from it by distillation. Next, the watery solution is washed three or more times with small quantities of ether, until the ether, after vigorous shaking and separation, comes off nearly colorless. These ether washings are then added to the ethereal extractive from which the ether is to be recovered by distillation.

Next, a fresh portion of ether, equal to about 3 per cent. of the coca represented, is added to the watery solution, and then a considerable excess of crystals of carbonate of sodium—say, about 0·75 per cent. of the coca represented—and the whole is well agitated. This precipitates the alkaloid from the watery solution, and the alkaloid is then dissolved at once in the ether by the agitation. When the liquids separate, a few crystals of carbonate of sodium are added, to ascertain whether the precipitation be complete. If these cause a precipitate in the lower watery solution, more of the sodium salt is added with fresh agitation, until the last additions cause no cloudiness. The liquids are then separated, and the watery solution is washed once by active agitation with a small quantity of fresh ether, and the ether being separated and added to the larger portion, the watery solution, now practically exhausted of alkaloid, is thrown away.

The ether now holds the free alkaloid and some coloring matter in solution, and the next step is to saturate this alkaloid with acid, and wash it out of the ether as a salt insoluble in ether. This is done by agitation with a small quantity of water containing about 10 per cent. of hydrochloric acid.

This time the acid should not be in great excess, and therefore several washings are made with small quantities of the weak acid, until the last one gives no cloudiness with carbonate of sodium solution. The ether, now practically free from alkaloid, is added to the other ether residues to be recovered by distillation. The watery solution of crude hydrochlorate of cocaine is then slowly percolated through the purified bone-black, the proportion of black being about 0·5 per cent. of the coca represented. The solution should come through the black of a very pale, greenish yellow color. It is then again precipitated by carbonate of sodium in excess in the presence of ether, when it yields a pale yellow ethereal solution of the free alkaloid. That is separated, and held in a stoppered, globular separatory funnel of large size, and is now ready for the separation of the yellow matter which has been supposed to be another alkaloid of coca, and called hygrine.

If the coca represented in the process be about 45 kilos., or 100 pounds, about 5 c. c. or 80 minims of strong hydrochloric acid, specific gravity 1·16, is dropped into the ethereal solution and thoroughly shaken with it. A very dense yellow solution of hydrochlorate will then separate, leaving the ethereal solution nearly or quite colorless. The dense solution of hydrochlorate is drawn off, and if the ethereal solution be not sufficiently free from the yellow tint, another smaller portion of acid is dropped in, well shaken, and separated as before. If the previous management has been skillful, one or at most two portions of acid will leave the ether solution sufficiently decolorized, that is, of a very pale, greenish yellow tint.

The remainder of the alkaloid in the ether is now almost absolutely pure, and it is to be exactly saturated by careful additions of a somewhat more dilute acid with careful testing by litmus paper of each solution drawn off. The final solution drawn off will necessarily be acid if the ether be washed clean, and this is not to be added to the other portions which are neutral, but is reserved for the next process. The portions which come off neutral are of a yellow tint, but they yield a nearly white salt. They are evaporated together at a low temperature with a most constant stirring until they cease to lose weight, and the salt is then powdered and passed through a sieve of about sixty meshes to the inch.

The very dense and very yellow portions are reserved until they accumulate from several processes. They are then diluted with water to about ten times their volume, and the solution is passed through a fresh portion of bone-black, and treated exactly as the original solution was.

Each separate lot of, say, 600 to 800 pounds of coca is conveniently divided into six or eight processes of 100 pounds each, or three or four processes of 200 pounds each, and the residues from them are then economically worked up together at the end, and thus the yield of each lot is pretty accurately obtained.

Two such lots of the inferior brown leaves, which quality only has been accessible in this market in any considerable quantity, for many months past, when worked up by this modified process, yielded, the one 0·19 per cent. and the other 0·23 per cent. That is, the first yielded over 13 grains, and the second 16 grains of the hydrochlorate of cocaine to the pound of the inferior coca.

THE ASSAY PROCESS.

This process has been modified in application from that given before, exactly in accordance with the manufacturing process just given.

As this method of assay is applicable to many of the alkaloids, and will therefore be referred to hereafter, and is both convenient and easy, it is worth while to give it in detail as now modified. It does not pretend to great accuracy, and is therefore not adapted to the use of the few scientific chemists; but in common with other processes, and other work, given in these pages, is useful to the many pharmacists and manufacturers who are satisfied with moderately close approximations of the strength and value of the materials which they use.

The method is applicable to all alkaloids which are soluble in liquids not miscible with water, or soluble in water to any great extent, and which do not themselves take up much water; and which do not dissolve the salts of the alkaloids. For example, ether, chloroform, amylic alcohol, benzene, carbon disulphide, kerosene, etc., each dissolve certain alkaloids when in the free state, but yield them up when combined with an acid. That is, the alkaloids are freely soluble in these liquids, but the salts of these same alkaloids are insoluble. Therefore, if the liquids hold free alkaloids, these can be washed out of them by acidulated water, if the acid of the water combines with the alkaloid to form a salt soluble in water.

Then, again, watery solutions of salts of the alkaloids can be washed free from these alkaloids, by means of these liquids, by the addition to the mixture of an alkaline precipitant which, by combining with the acid of the salt, sets the alkaloid free in the presence of the solvent liquid. The washing out is done by active agitation, after which the two liquids are allowed to separate as completely as possible, and the heavier liquid is then drawn off from the lighter one. As all the solvent liquids used dissolve a little water, and water in its turn dissolves a little of the liquid, repeated washings and separations become necessary, since that portion of the solvent liquid dissolved by the water and that portion of the water dissolved by the liquid each hold a small proportion of alkaloid.

To carry on these repeated washings and separation of liquids rapidly, and with a fair degree of accuracy and convenience, a separating apparatus of some kind is essential, and the writer some years ago combined the shaking flask with the separating funnel with very great advantage to this and many other processes.

With some such conveniences the method is very simple and easy of application, as it entirely avoids troublesome filtrations, and the chief difficulty is in washing the liquids clean, especially when they are loaded with extractive matter or with salts of the alkaloid used for precipitation. The final evaporation of volatile liquid leaving the alkaloid to be weighed is not difficult if done in a beaker or other straight sided vessel, to prevent creeping, and the coloring matter, etc., which remains to be weighed as alkaloid, does not probably exceed the alkaloid which escapes the washing out process.

The 50 grammes of coca in fine powder is moistened with 40 grammes of strong alcohol to which has been added 0·08 gramme of sulphuric acid specific gravity 1·843, or 0·16 gramme of hydrochloric acid specific gravity 0·16, packed in a percolator, and, if there be no haste, allowed to stand overnight. It is then percolated with strong alcohol, not acidulated, until exhausted or until the percolate amounts to about seven or eight times the weight of the powder. The percolate is evaporated at a low temperature until free from alcohol. This extract is rinsed into a separator by the successive application of water and ether until about 25 to 30 c. c. of each liquid has been used, and the whole of the extract transferred. Next, 1 or 2 c. c. of 10 per cent. acid is added, and the whole is vigorously shaken. If this mixture forms an emulsion which does not separate within an hour or two, a further addition of acid and a repeated agitation will cause a more prompt separation. The lower watery solution is drawn off into another separator, and the ether residue is washed with 10 c. c. of acidulated water, this washing being added to the watery solution, and the ether residue being thrown away. The watery solution is next washed with successive portions of ether of about 10 c. c. each, until the ether remains nearly colorless, as the liquids are separated from one separator to the other.

Add 10 c. c. of fresh ether and an excess of crystals of carbonate of sodium, agitate well, draw off the watery solution into the other separator, and the ethereal solution into a small tared baker. Wash the watery solution with 10 c. c. of fresh ether, and add this to the first portion in the beaker. The beaker then contains practically the whole of the alkaloid in ethereal solution. By setting this in a warm place, the alkaloid is soon left in a crystalline film or a varnish-like coating upon the bottom and sides of the beaker, where it is dried until it no longer loses weight. The weight is then taken, and this may generally be accepted as the proportion of crude alkaloid. If the crystals be rinsed off twice with 5 c. c. of distilled water each time, and be then again dried and weighed, the assay will be closer. If the alkaloid be left in the varnish-like condition, the washing with water will cause it to crystallize, after rinsing the water round the beaker for a time without a stirrer. The crystals should then be entirely but slowly soluble in 10 c. c. of very dilute acid, and the solution should give a strong impression upon the tongue characteristic of cocaine. The result appears to be a very close approximation to what the coca yields, but it does not yield as much to the manufacturing process by about 10 per cent., chiefly on account of the loss in the bone-black and by splitting up.

A sample of Bolivian coca recently received yielded by this assay process 0·55 per cent. of alkaloid. This, however, was exceptionally fine coca, and if such could be obtained in quantity it would doubtless yield 0·5 per cent. of the hydrochlorate, or say 35 grains to the pound.

A sample from a lot of about 3,000 pounds recently received gave 0·5 per cent.

* From *Ephemeris*, May.

SEPARATION OF LIQUEFIED ATMOSPHERIC AIR INTO TWO DISTINCT LIQUIDS.

By S. WROBLEWSKI.

THE laws of the liquefaction of atmospheric air are not those of the liquefaction of a simple gas. If at first sight air presents itself in such a manner that it is permissible to speak of the critical point of the air, this depends merely on the slight difference which exists between the curves of tension of watery vapor, of oxygen, and of nitrogen. While the vapor tension of the liquid evaporated by the pump continually diminishes in a progressive manner, the temperature passes through a series of maxima and minima. Under low pressures it ultimately arrives at values little higher than those presented by pure oxygen at the same pressure. In these conditions the air contains merely a very slight quantity of nitrogen. Air can further yield two quite distinct liquids, different in appearance and composition, the one superimposed upon the other, and separated by a perfectly visible meniscus. The author arrived at this result as follows: After having liquefied at —142° a quantity of air in the tube of his apparatus, he allows such a quantity of gaseous air to enter the tube that the pressure of the gas is equal to 40 atmos., and its optical density equal to that of the liquid. The meniscus of the liquid is effaced, and disappears entirely. He then slowly diminishes the pressure, and at the moment when the gauge shows a pressure of

97·6 atmospheres a new meniscus appears at a point of the tube much higher than that occupied by the meniscus which has disappeared. A few moments afterward the old meniscus returns to the point where it disappeared, and at this moment two liquids are distinctly recognized, and remain separate for some seconds. The lower liquid contains 21·28 vols. per cent. of oxygen, and the lower 17·3 to 18·7 per cent.

COMPOSITION OF OCEAN WATER.

MR. W. DITTMAR has given (Proc. Phil. Soc. Glasgow, vol. xvi., Dec. 3, 1884) a summary of his results obtained in the investigation of the specimens of ocean water brought home by the Challenger expedition. We cite briefly from this abstract. Mr. Dittmar remarks in the outset on the small change in the constitution of the solids in solution in the ocean produced by the contributions of rivers, stating that the estimated annual amount from the thirteen principal rivers of the earth, $1·337 \times 10^9$ tons (of 1,000 kilos. each), when compared with the amount in the ocean water of dissolved solids (46,280 billion tons in the 1·3 trillion tons of water), is so small that it would take 30,000 times as much to tell distinctly on the most exact sea water analysis which could be made by our present methods.

The water was found to contain an appreciable amount of base over and above that which would neutralize the two principal acids, and this is in the state of *carbonate;* and part of this carbonate must be carbonate of lime. From the mean results of 77 analyses, this surplus base per 1,000 grammes of ocean water is equivalent to 0·25 gramme of carbonate of lime; but this number may need a correction, considered beyond. The following table gives the results of Mr. Dittmar's 77 analyses:

AVERAGE COMPOSITION OF OCEAN WATER SALTS.

	Per 100 parts of Total Salts.	Per 100 of Halogen calculated as Chlorine.	
	Dittmar.	Dittmar.	Forchhammer.
Chlorine	55·292 (*	99·848	Not determined.
Bromine	0·1864)	0·3362	Not determined.
Sulphuric acid, SO_3	6·410	11·576	
Carbonic acid, CO_2	0·152	0·2742	Not determined.
Lime, CaO	1·676	3·026	2·99
Magnesia, MgO	6·200	11·212	11·08
Potash, K_2O	1·332	2·405	1·98
Soda, Na_2O	41·234	74·462	Not determined.
(Basic oxygen equivalent to the halogens)	(-12·493)	...	...
Total salts	100·000	180·584	181·1

Combining acids and bases, we have (Dittmar):

Chloride of sodium	77·758
Chloride of magnesium	10·878
Sulphate of magnesium	4·737
Sulphate of lime	3·600
Sulphate of potash	2·465
Bromide of magnesium	0·217
Carbonate of lime	0·345
Total salts	100·000

Reducing to the absolute mass of the ocean as given above, we arrive at the following numbers:

ABSOLUTE COMPOSITION OF THE SALTS OF THE OCEAN.

Unit=1 billion=10^{12} tons.

Chloride of sodium	35,990
Chloride of magnesium	5,034
Sulphate of magnesium	2,192
Sulphate of lime	1,666
Sulphate of potash	1,140
Bromide of magnesium	100
Carbonate of lime	160
	46,283

Total bromine..... 87·2 (W. D.)
Total iodine..... 0·03 (Kottstorfer.)
Total chloride of rubidium... 25·0 (C. Schmidt.)

Mr. Dittmar adopted Tornoe's expression numerically for the *alkalinity* of the water by stating the number of milligrammes of CO_2 which would convert the surplus base into normal carbonate, and referring it to one liter of sea water analyzed, or—to get rid of degree of salinity—referring it to 100 parts by weight of total salts in the water, or to 55·42 parts of halogen counted as chlorine. The statement that the alkalinity =0·154 signifies that per 100 parts of total salts the water contains 0·154 part of CO_2 as normal carbonate, or rather in the $R'O,CO_2$ part of the carbonate as formulated. The alkalinity ranged from 0·140 to 1·064, with a tendency to the highest results in the bottom waters. One cause of more lime carbonate in the bottom waters is found in the shells of dead crustaceans, etc., over the bottom. Some free CO_2 also may be present.

The *salinity* of the waters is oceanographically a function of the geographic position, depth, and time. Mr. Dittmar determined, from comparisons of ascertained specific gravities with chlorine determinations, that the per-millage of chlorine in an ocean water at a given temperature is proportional to the excess of its specific gravity above that of pure water at the same temperature. This is expressed in the formula,

$$_tS_t - _tW_t = \chi(a + bt \times ct^2),$$

where $_tS_t$ denotes the specific gravity of sea water, and $_tW_t$ that of pure water at $t°$, both referred to pure water at + 4° C. as = 1,000, while a, b, and c are constants having the values

$$a=1·45093,\ b=-0·0055922,\ c=0·0000649.$$

The results agree closely with the determinations of specific gravities of Challenger waters by Mr. Buchanan, of the Challenger expedition.

The *atmospheric constituents* of the waters were also studied. Buchanan followed Jacobsen's method in collecting the gases from the waters. Mr. Dittmar found that in the surface waters the oxygen and nitrogen vary in amount from temperature, but the waters nowhere contain more than 15·6 c. c. of nitrogen or more than 8·18 c. c. of oxygen per liter; and that the nitrogen never falls below 8·55 c. c. The oxygen is diminished below its theoretical minimum—4·30 c. c.—by the processes of life and organic decomposition and other oxidation changes. In waters at depths the variation in amount of oxygen is greater, because of the feeble source of supply and the losses from oxidation. No deep sea water was found, in the analyses, wholly without free oxygen, and this "confirms the conviction that absolute stagnation nowhere exists in the ocean, nor even at its greatest depths." But in one sample the amount of cubic centimeters per liter was found to be 15·08 N_2 and 0·6 O; in another, 13·38 N_2 and 2·4 O; "indicating approximate rest at these two places at any rate." At the ocean's surface the equilibrium in the absorbed nitrogen and oxygen is maintained by the atmosphere.

As to *carbonic acid in sea water*, all the waters were found to contain it, and those from the deep sea were particularly rich in it. The analyses prove that "if sea water anywhere contains free CO_2 at all, it amounts to little in comparison even with the combined CO_2 of the carbonates." But sea water may give off CO_2 even when only enough is present to make all the lime bicarbonate. Experiments showed that the loss may continue until there remains only what is necessary to make the lime a sesquicarbonate. "In surface waters the proportion of carbonic acid increases when the temperature falls, and *vice versa;*" and "within equal ranges of temperature it seems to be lower in the surface water of the Pacific than it is in that of the Atlantic Ocean." Free carbonic acid is, however, occasionally in rather large proportion, 22 out of 195 waters analyzed by Mr. Buchanan having their surplus base at least fully saturated, and one, although a surface water at 25·1° C., contained as much as 41 milligrammes of free CO_2 per liter."

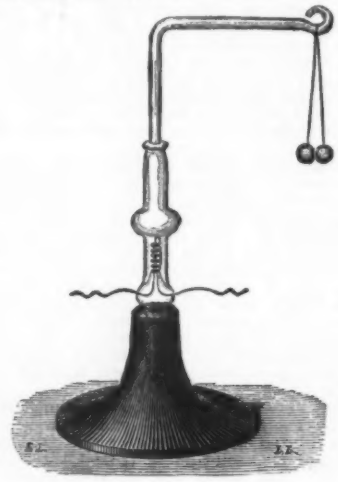
The total weight of potential carbonate of lime in the ocean amounts to 160 billion tons, equal to 70 such units of CO_2; but as the CO_2 is present as partially saturated bicarbonate, 105 billion tons may be accepted as a rough approximation. The source of this CO_2 Mr. Dittmar surposes to be from submarine volcanic action. As volcanoes get the CO_2 by decomposing limestone about the conduit, it would in that case come from the calcareous material of the ocean's depths, or from the earth's crust beneath, set free by volcanic heat.

The total weight of loose CO_2 in the ocean is at least fifteen times greater than that of the free CO_2 in the air. If the amount of lime carbonate contributed by all the rivers of the world is assumed to equal the total solids which the thirteen rivers before named contribute, $1·3375 \times 10^9$ tons, it would take them 1,194 years to increase the amount in the ocean one per cent. of its present value, the sum total of the carbonate of lime of the ocean being 160 billions of tons.

* Equal conjointly to 55·376 parts of chlorine, which accordingly is the percentage of "halogen reckoned as chlorine" in the *real* total solids.

A NEW INSULATING SUPPORT FOR EXPERIMENTS IN STATIC ELECTRICITY.

THE glass supports employed for experiments in static electricity, as well known, often lose their insulating power on account of the moisture that deposits upon their surface and forms a conducting stratum.



In order to obviate this, the idea has occurred to place these supports in an atmosphere kept constantly dry by sulphuric acid, and it is upon this principle that are based the well known insulators of Sir William Thomson and Mr. Mascart.

Formerly it was necessary to heat the glass rods, by various processes, until they reached a temperature slightly higher than that of the surrounding air, so that aqueous vapor might no longer condense upon them. Mr. De Fonvielle has thought that it might be advantageous in certain cases to have recourse to this old process, but to modify it by placing the rods in tubes heated internally during the experiment by a spiral incandescent platinum. The annexed figure shows the application of this idea to a pith-ball electroscope. A simple bichromate pile suffices to render the spiral incandescent.—*La Lumiere Electrique.*

ELECTRICAL STORAGE BATTERIES.

C. H. HENDERSON.

FEW inventions have raised such high hopes of universal usefulness as the electrical storage battery, and for a time at least few have been pronounced such dismal failures. When the secondary battery was first announced as a reservoir for electrical energy, everything was thought to be possible through its agency, and its field of application seemed as unlimited as the imagination itself. It was to bring new help to industry and to turn the wheels in house and factory with little inconvenience or expense. Bottled electricity proved an immensely taking idea. To have a concentrated energy delivered at one's door every morning, in sufficient quantity and in a highly compact form, seemed to throw a host of inconveniences and difficulties into a distant background, and to give form to just the sort of power for which men had been wishing. But when it was found that these pleasant expectations were not to be realized, and that most of the announcements made in its favor had been extravagant almost to the ridiculous, the new batteries fell into disrepute. The quackery which had heralded the appearance of the Faure battery was believed to belong to all batteries as a class, and the public ceased to be interested in what seemed to them as a mere physicist's bubble. In the mean time, however, electricians have been steadily at work improving the secondary battery, and now it promises to have a usefulness almost as great as had first been imagined for it, though its field will necessarily differ from that first anticipated. So common have references to storage batteries become, that it seems worth while for even general readers to take the time to briefly examine their genesis and constitution.

It was in the early part of the present century that the fundamental observations upon which the secondary, or storage, battery rests were made by a French chemist, M. Gautherot. He was the first to make the observation that when two platinum electrodes in dilute sulphuric acid are connected, after an electric current has been passed through them, a secondary, or polarization, current will pass in the opposite direction to the primary current, and may be measured by a galvanometer. To understand this reaction is to understand the theory of the modern storage battery. At one pole, hydrogen is evolved, and at the other oxygen; these adhere to the electrodes and even penetrate the metal, so that, when the two poles are connected, the establishment of an electrical equilibrium generates a current in a reverse direction. It will thus be seen at the outset that as a chemical reaction generates a current in the primary element, so the absorption of this current in a secondary battery is to accomplish another reaction; this produces an unstable condition of equlibrium; and a metallic contact between the poles of the battery, thus charged, is sufficient to restore this equilibrium, by permitting the electrodes to return to their original chemical condition, the result of which is a reversed current. One must get rid of the notion that electricity is absorbed as such by a secondary battery, and then given up again. This of course is the practical result, but the intermediate stages must be borne in mind if one would understand the *rationale* of the process. A sponge in a damp place absorbs moisture, which is afterward given up by pressure or evaporation; but the action is entirely physical, and must not be compared to that of the battery, for in this case there is strictly no absorption or giving up in the popular sense of the word. The primary current expends itself in doing chemical work, and is *thus stored* up in the battery. A counter action, the undoing of this chemical work, gives out the reversed current. Work is absorbed, and work is given out; electricity is simply the cause and the result of this mutual reaction.

The year following Gautherot's observations, Ritter of Jena made use of this reaction in the construction of the first electrical accumulator. His voltaic battery employed but one metal, the disks of which were made active by polarization. Two plates of gold were separated by a piece of flannel moistened with acid and charged by an ordinary pile. When the plates were connected, a current flowed in the opposite direction to the charging current, and thus electrical storage became known. This was in 1803, and more than half a century was to pass before any practical use was to be made of the discovery. It was not until 1859 that the first practical form of secondary battery was brought out by the celebrated French physicist, Plante. The action of his battery deserves particular attention because all those now in the market are built upon the same principle, and differ from it only in certain details of construction. When two sheets of ordinary lead are immersed in dilute sulphuric acid, and a current passed through them, a deposit of peroxide of lead is formed on the plate connected with the positive pole of the battery, or the anode, and hydrogen will separate at the other plate, the cathode, and reduce it slightly to the condition of spongy lead. It will be noticed that the action here is the same as in Gautherot's experiment. The oxygen separated at the anode is chained by its combination with the lead in the peroxide formed, and the nascent hydrogen at the cathode is exercising its reducing action upon the sulphate or other salt of lead which may exist at that pole. If now the lead plates be disconnected from the primary battery, and be connected to each other, a powerful current will flow in the reverse direction, that is, from the brown peroxidized plate to the reduced plate. The production of this current is very easily explained. The primary current is allowed to pass until bubbles of oxygen escape from the anode, showing that all the useful work possible, that is, all the peroxide of lead which can be formed, has been accomplished, and that any further flow of the current is simply wasted. The secondary current results from the undoing or reversion of this work; the peroxide of lead at the anode is deoxidized and reduced to metallic lead again, while the oxygen liberated combines with the cathode, forming oxide of lead. In practice, a Plante accumulator is constructed of two sheets of rolled lead separated from each other by strips of India rubber. These strips are one centimeter wide and half a centimeter thick, being as long as the plates which they separate. Two are used between the plates, and two more are placed on top of the upper plate, after which they are rolled into a spiral on a wooden cylinder. Each sheet is provided with a connecting strip, and the lead spiral, held together by rubber clamps, is placed in a cylindrical vessel. This has a non-conducting cover, which is provided with openings for the connecting strips and for pouring in the electrolyte, a mixture of water and ten per cent. of sulphuric acid. Such is the material of the element, but it is far from being completed, for the most tedious part of the process, the electric "forming," is still to be accomplished. When first used, the lead plates are compact and offer but little surface to the action of the current. Consequently the amount of peroxide formed is relatively small, and the discharge current is of short duration. To obviate this difficulty, the plates must be "formed," as Plante expresses it, which is accomplished by rendering them more porous, and therefore capable of more energetic action. This process of forming occupies several months, and consists of repeated charging and discharging of the plates, the primary current each time being sent through them in an op-

posite direction. The accumulator, when well formed, is able to keep a platinum wire one millimeter thick glowing for ten minutes or a wire one-tenth of a millimeter thick glowing for an hour. It is very simple and efficient, and would be largely used were the difficulties of forming the plates not so great; as it is, the time and trouble required by this process have hindered the battery from coming into general use, and have caused it to be supplanted by various modifications. Of these, the most important, because it has given rise to a distinct type of accumulator, is that devised by Faure in 1880. In his instrument, the lead plates are coated with a thick layer of a paste made of sulphuric acid and minium, or red lead. This is rapidly peroxidized and reduced at one charge, so that the long process of forming is done away with. The oxide is kept in place by a covering of parchment paper and a layer of felt. Otherwise, the element is formed the same as the original Plante cell. It has several disadvantages, however, and has led to further modifications. The felt separator adds largely to the internal resistance of the battery, and the oxide is apt to fall down to the bottom of the paper bags, and by unduly distending them give rise to short circuits. But with all its imperfections, the Faure battery was an improvement over the original Plante cell, both in the time required for its formation and in the storage capacity which it offered. For the same weight of lead, the Faure battery gives fifty per cent. greater electrical capacity than the Plante, and this is naturally an important consideration where the batteries are to be used for purposes where portability is essential. These advantages have led recent inventors to utilize the principle of the Faure battery, and to remove its shortcomings by mechanical improvements. The one which is perhaps the best known, at least abroad, is that devised by Messrs. Sellon and Volckmar, and known by their joint name. As it is chiefly manufactured by the Electrical Power and Storage Company, of London, it is commonly referred to as the E. P. S. accumulator, and has met with a large application in England. In it, the bandaged lead plates are replaced by a lead grid or perforated plate, into the apertures of which the paste of red lead and acid is forced and held by its own compression. In some forms the edges of the apertures are beveled, in order to hold the paste more securely, but this is not at all necessary, as the red lead expands during its transformation into the peroxide, and obtains a secure hold upon the grid. The plates are separated by rubber strips and placed in the usual dilute sulphuric acid. They are commonly about an eighth of an inch thick and ten inches square. The efficiency of these cells is very high; those employed for motive purposes have a storage capacity of 48,000 foot pounds per pound of lead employed, or four times that of the Plante element; but for electric lighting a common form is the so-called "one horse power" cell, which carries when fully charged an amount of energy equivalent to 1,980,000 foot pounds, or one horse power for one hour. Each cell has 16 plates, the total weight of which is 48 pounds. They are contained in rectangular wooden boxes lined with lead, and 12⅛ inches high, 11⅛ inches long, and 5¾ inches wide, outside measurement, so that two of them just about occupy a cubic foot of space. The total weight of one cell is 79½ pounds.

Professor Henry Morton, of the Stevens Institute of Technology, has carefully examined these cells, and his results are of interest as affording the data necessary for a computation of the number required for a given purpose. A fully charged cell gave a current of 32·5 amperes at the beginning and 31·2 amperes at the close of a nine hours' continuous discharge. As an Edison incandescent lamp of high resistance and 16 candle power requires a current of 0·73 of an ampere, 44 such lamps would be supplied by one cell. The electromotive force necessary to overcome the resistance of that number of lamps would, however, require about 50 cells. If the time of discharge be made shorter, a comparatively larger number of lamps could be supplied by the 50 cells, or if the number of lamps be less, a comparatively longer discharge would be possible. Thus, for instance, 11 lamps would run for 36 hours, or, as five hours is the usual time during which lights are required in private houses, the 11 lamps would suffice for a week.

But other improvements in secondary batteries have also been made by retaining Plante's cell and reducing the time of formation to a much shorter period. One of the first of these was that patented by M. Gaston Plante himself, in 1883, which consists in submitting the sheets of lead to the action of nitric acid diluted with once or twice its volume of water for the space of twenty-four hours. This preliminary immersion serves to increase the porosity of the lead, and consequently its capacity for the formation of peroxide. Plates formed in this manner are as efficient after once charging from a primary battery as the unacted upon plates after several weeks of careful charging and reversion, though even in this case a short process of "formation" is beneficial. Almost simultaneously two English experimenters brought forward a similar process for forming the plates, and gave their results to the public in the Elwell-Parker battery, now quite well and favorably known. In this, the plates are immersed in a preliminary bath of dilute nitric and sulphuric acids, by which their surface is honeycombed and made very susceptible to the action of the charging current. A deposit of sulphate of lead is formed, which is afterward reduced to peroxide. The mechanical details of the cell have also been very carefully arranged, and it is among the most convenient of secondary batteries.

In America, the use of storage batteries is as yet somewhat limited, but it is daily being extended. The form most in use is that devised by Mr. Brush, of electric lighting fame. It is of the Plante type, and differs from the original only in certain details of construction. The formation of peroxide of lead continues indefinitely as long as the charging current passes, but becomes slower with the increased thickness of the coating. When the current is stopped, a reaction takes place between the peroxide and the metallic lead, by which the one is reduced to a lower state of oxidation and the other is oxidized by the oxygen thus liberated. Consequently, when such a plate is recharged by a primary current, its capacity will be found to have increased, and this explains the beneficial effect of the repeated charging in forming the Plante cell. On the other hand, there is little increase in the capacity at the hydrogen pole, for it has been found that the plate absorbs a definite amount of hydrogen, which changes but little with further action of the current. Activity at one pole, however, presupposes a corresponding activity at the other, and the oxygen capacity can only increase with a similar progression in the hydrogen capacity. Hence it is that a reversal of the charging current, by offering a coating of peroxide of lead to the reducing action of the hydrogen, gives a greater capacity from the spongy lead formed at the cathode. In this way the efficiency of both plates is correspondingly increased. In the Brush battery the plates are so charged that both have a good coating of peroxide formed upon them, and after they are associated together in the battery, and a current passed, one plate remains unchanged and the other has its charge reversed and forms the hydrogen element. Mr. Brush also proposed the process of electrically coating the plates with a film of metal before the "formation." The reaction between the peroxide of lead and the metal explains the loss of charge which takes place when a battery stands for any length of time, for the lower oxide is entirely useless for the generation of a secondary current. Three Sellon-Volckmar cells experimented upon by Professor Morton showed a loss of seven per cent. after standing sixteen days. There are of course other causes for the gradual discharge of a battery, such as imperfect insulation or the presence of moisture, but these are largely preventable, and are not essential to the theory of the secondary battery, though a number of writers upon the subject have apparently found in them a sufficient explanation.

The use of storage batteries entails a considerable economic loss, for the amount of charging current is never realized in the discharge. With the improvement of the battery, however, a constant increase in its economy is also effected. The loss varies with the time during which the battery remains charged. In the early days, sometimes but sixty per cent. of the charging current was realized at the discharge, but in some of the later forms as much as ninety per cent. is stated to have been obtained. Mr. Preece's experience with well formed Plante accumulators gave, we believe, but seventy per cent. of the charging current. It is, however, almost the universal testimony of those who have had any experience with the accumulators that their convenience is more than compensation for their greater expenditure of energy, and indeed under certain conditions, as for instance where variable power is to be utilized at odd moments, the economic advantage may even be stated to rest with the accumulator.

The applications of the storage battery are so varied, so numerous, and so well known that any enumeration of them would seem quite unnecessary, but it may not be out of place to call attention to the dual field which they are apparently to occupy, since the construction of a battery will largely depend upon the uses to which it is to be put. Where portability is required, as in aerial propulsion, in motors for vehicles or boats, in reservoirs for the electric lighting of cars and carriages, or for similar purposes, the main object in view will be to obtain the greatest electrical capacity per pound of battery. But where it is simply used as a reservoir from which a constant current may be drawn, or in which a variable energy may be utilized and stored, the economic efficiency will be the dominant consideration, and in many cases may make a more cumbrous form preferable. While the storage battery makes a great many novel enterprises possible, its greatest use must be in supplying some staple demand. Next to bare existence, few wants are more pressing than that of light, and it is in this direction that the present battery offers the greatest advantages. There are many positions in which the power necessary to generate the electric current is all sufficient in quantity, but is available only at odd moments or during the day time, and which would otherwise be entirely wasted. This could not possibly be utilized in the direct production of the electric light, but at once becomes available when the reservoir of an accumulator is employed as an intermediate link. Many motors, such as those which depend upon water, wind, or gas, which would otherwise be unsuitable on account of their varying velocities, may be conveniently utilized by this preliminary storage. We do not forget in reciting these advantages that the life of the secondary batteries is still a mooted point, but so much has already been done in perfecting them, and our experience in this direction, though limited, points to such favorable results, that we may confidently expect longevity to be among the other merits of the accumulator.

UNDERGROUND TEMPERATURES.

THE Proceedings of the Royal Society for Feb. 12, 1885, contain an abstract of a paper on underground temperatures by Professor J. Prestwich. The author reviews the published facts and the conditions in the several cases, in order to eliminate the more doubtful ones, and reach the probable normal rate of decrease in temperature, or thermic gradient. The various determinations give a range in the rate from less than 30 to more than 120 feet per degree; and 30 meters for 1° C. (= 54·7 feet for 1° F.) is the commonly adopted rate in Europe, while in England 50 feet is adopted by some and 60 or more by others. He considers the conditions in (1) coal mines, (2) other mines, and (3) artesian wells and bore holes; and the action in modifying temperature taking place in mines through (1) ventilation, (2) underground flows of water, (3) chemical reactions, and (4) the working operations; and, in artesian wells, from (1) pressure of water on the thermometers, and (2) convection currents in the column of water.

In the ventilation in coal pits, the amount of air passing through varies from 5,000 to 150,000 cubic feet per minute, and has a large cooling effect. It is generally greatest in the deepest mines. The escape of gas from a blow hole is also cooling, usually lowering the temperature 2° or 3°; and in one case the temperature of 74° F. existed in the coal at a depth of 1,588 feet, and 62° F. in a hole with a blower of gas at a depth of 1,588 feet. The discharge of water causes a loss of heat. On the other hand, a crushing of the coal raises the temperature. There is also variation dependent on the form of the surface above, it rising under hills and falling under valleys. For correct determinations from coal mines, therefore, the height of the pit above the sea level should be known; the exact mean temperature of the place; the depth, at each station, beneath the surface; the temperature of the air in circulation; the length of exposure of face; whether there is discharge of gas or not; the dip of the strata; and the quantity of water discharged.

Eliminating the more doubtful observations, the seven best—at Boldon, North Seaton, South Hetton, Rosebridge, Wakefield, Liege, and Mons—give a mean gradient of 49¼ feet for 1° F. The bore holes at Blythswood, South Balgray, and Creuzot give a mean of 50·8 feet.

In other mines, the loss of heat by ventilation is much less than in coal mines, and that from pumped water far more. In the Gwennap district, where 550 acres were combined for drainage purposes, above 20,000,000 gallons have been discharged in twenty-four hours from a depth of 1,200 feet; the water issues at temperatures from 60° to 68° F., or more than 12° above the mean of the climate, showing a large abstraction of heat from the rocks through which the waters percolate. Again, surface waters may enter, and lower the temperature. The underground currents sometimes raise and sometimes lower the temperature of the rocks. Mr. Were Fox, in his many careful observations on undergrond temperatures, gave preference to the rocks, and Mr. Henwood, an equally experienced observer, considered the springs as giving surer results. The ten best of Mr. Henwood's observations, at depths from 800 to 2,000 feet, give a mean of 42·4 feet per 1° F.; and the observations in eight mines, 1,100 to 2,100 feet deep, by Mr. Fox, give 43·6 feet per 1° F. The observations in European mines Professor Prestwich regards as too uncertain for use.

From artesian wells and borings, when the connection waters are shut off by tubing, and when the pressure of the waters on the thermometer was guarded against, as those made at Kentish Town, Richmond, Sperenberg, Pregny, and Ostend, give 51·9 feet per 1° F. In these wells the waters do not overflow. In others which do overflow, and which should therefore give the best results, as at Grenelle, Tours, Rochefort, Mondorff, Munden, and others, the mean afforded is 50·2 feet per 1° F. In the Sahara Desert, the mean from eleven overflowing wells at depths of 200 to 400 feet gave 36 feet per 1° F. The author also considers the variations resulting from difference of conductivity in rocks, but makes no application of the subject.

The mean thermic gradient deduced from all the observations is 48 feet per 1° F.; but this is considered only an approximation. The question of change of rate downward also is considered, but the facts reviewed gave as regards this point no satisfactory result. Professor Prestwich inquires in closing whether a gradient of 45 feet per degree may not be nearer the true normal than 48 feet.

CULTIVATION OF CINCHONA IN GUATEMALA.

Report by U. S. Consul General WHITEHOUSE.

WITH a view to the feasibility of the introduction of the cinchona tree into some of our Southern States, I have the honor to submit the following report on the cultivation of the tree in this republic:

Cinchona was first introduced into Guatemala about seven years ago, but the treatment not then being thoroughly understood, only about 1,000 trees have reached maturity.

A sample of "succirubra" bark of one of these trees was analyzed in February last, and yielded a quinine of excellent quality and above the pharmacopœial standard. A sister tree of the same age (seven years) was lately cut down, and yielded forty-three pounds of wet bark, which, when dry, will be about fifteen pounds. These trees are growing at an elevation of 5,000 feet, and have occasionally been exposed to frost.

Cinchona is not tropical, although it may be called semi-tropical. In Southern India and Ceylon it is cultivated at elevations higher and colder than those on which coffee can be grown.

About two years ago the Government of Guatemala determined to introduce the cinchona on a large scale, and having secured the services of Mr. W. Forsyth, an experienced planter, sent him to India to procure fresh seeds. The seeds were obtained and planted in carefully selected nurseries at elevations of from 4,000 to 5,000 feet above the sea, and close to the limit of the coffee zone, in the districts of San Marcos, Tumbador, Costacuca, Grande, Coban, Antigua, and Guatemala.

In these nurseries the following varieties of cinchona were sown: succirubra, officinalis, condamenea, robusta, and a little calisaya.

CULTIVATION.

Through the courtesy of Mr. Forsyth, I am able to give the following information concerning the modes for raising the plant which he has adopted in this country:

To raise the cinchona nurseries, the first thing was to select fully ripe seed from matured trees, and to sow as soon after as possible. The seeds are apt to deteriorate and die if kept for a long time, and particularly if exposed to the air. The ground in which the seed was grown was raised in the form of beds about 3 feet in width, 20 feet long, and the ends facing east and west. Over these beds cheap temporary roofs were made, sloping toward the south, the reason for this being that the plant when sprouting requires all the light of day, but not the rays of the sun, a very little of which will kill it when sprouting. The top dressing on which the seed was sown was brought from under the shade of forest trees, because more free from insect life and foreign seeds than earth taken from grass land. In some cases the seed was soaked in cold water three or four hours before sowing, but this is not necessary.

The seed was watered daily until well through the ground; then only more rarely, as required. From the seed bed the seedlings, when two or three inches high, were planted out into extended nurseries, and shaded with ferns or small jungle twigs. This shade was gradually removed when the plants had formed new roots, and were strong and hardy. When about eighteen inches high they were permanently transferred to the plantation.

The plantation where the cinchona is to be cultivated must be cleared thoroughly. The plants are then lined, as in a coffee estate, 6 by 6 or 7 by 7 feet apart. The whole surface is weeded periodically, to prevent all foreign weeds from choking the young plants. As the trees get older this is done at longer intervals, and when they have attained sufficient height for the

branches to shade the ground well, may be almost discontinued.

GATHERING THE BARK.

There are several methods of harvesting the bark. The first is to cut the tree down to a stump and take all the bark off. From the stump, shoots will spring and grow to a full sized tree again. The second is to take off small strips of bark from top to bottom, leaving as much bark on as is taken off. Immediately after stripping the bark off, the wound is covered with any material which will quite exclude light and air. A thick covering of grass is frequently used. The bark will under these conditions be renewed on the wound and become much richer in alkaloids than the original was. A third method is to scrape the outer surface of the bark quite off, leaving the under tissue intact. The alkaloids which contain the properties from which quinine is extracted are mostly secreted in the outer surface, so that in scraping the whole harvest of alkaloids is collected. The inner half of the bark protects the tree and enables the sap to circulate.

"Succirubra cinchona" returns a much larger yield in bark than any of the others except "robusta," but is not so rich in alkaloids.

The richest of all is "legeriana calisaya;" next come the other calisayas, "officinalis," etc.

As I have said above, the cinchona reaches maturity and produces at an age of six or seven years, and will then have attained a height of some thirty feet.

The yield of the bark would of course depend on the method of harvesting and on many other causes. From twenty to thirty pounds, however, might be reckoned upon.

H. REMSEN WHITEHOUSE,
Consul-General.

Consulate General of the United States,
Guatemala, May 26, 1885.

PLANTS FOR MARGINS OF LAKES.

IT is often difficult to know what to plant on the margins of water, as much depends on the habit and appearance of the plants used for that purpose. Nor must the forms which their shadows have on the water be overlooked. The following I know from experience are fit for the purpose; they are all easily grown, hardy, and require no very expensive preparation of the soil in order to induce them to succeed. Tritomas make excellent water-side plants placed about 2 feet from the water's edge; their long, drooping leaves hang over and touch the water, and in such positions their richly colored spikes of bloom are very effective; they require abundance of moisture at the root, particularly if the water is bottomed artificially; when bottomed with concrete, no matter how near the water's edge the roots may be, no benefit in the way of moisture is experienced, such as would be derived from a clay bottomed or naturally made lake. Last April we planted a small plant of T. glaucescens in such a position, and now it has sixteen stately flower-spikes. This variety comes first into flower, and is succeeded by uvaria and grandis. If all three kinds are planted, a succession of flowers may be had. There is but little difference among these as regards color, but grandis has the largest flower-spikes. The pampas grass has a fine effect either in bloom or not. It should be planted 8 feet or 10 feet from the edge of the lake, and during summer be freely supplied with water. The reflection of its long plumes of flower is particularly good. Arundo conspicua is another plant well adapted for such a purpose, and it comes into bloom at the same time as the tritomas. It is, therefore, best planted in close proximity to them, the contrast in the way of color between the two being good. Statice latifolia succeeds well near water, especially if planted close to the margin, where its lovely blue flowers are produced in profusion. Plants of this variety can be easily raised from seeds sown in pans on a gentle hotbed in spring; when large enough to handle, they should be planted out on a border and allowed to remain there till they have reached a good size, when they may be planted in their permanent quarters. The double-flowered Caltha palustris is also a suitable plant to place near the water's edge, or, if necessary, partly in the water; its golden yellow flowers are freely produced, and are very showy in spring and summer; it is easily increased by dividing the roots. Some of the bamboos, such as B. metake, are hardy, and look well when planted close to the edge of the water, on which the reflection of their graceful forms is charmingly effective. The New Zealand flaxes (Phormium tenax and P. tenax variegatum) are specially adapted for planting near water, either among rocks or otherwise, but the more elevated the better. They are easily increased by dividing the roots; if planted among rocks, they should rise out of a carpet of Herniaria glabra, or some such carpeting plant. Hypericum patulum (St. John's wort), when planted in a mass, is also strikingly pretty when in bloom; it grows freely, and if only for its foliage effects it is well worth a place close to the margin of water. A little peat added to the soil greatly assists its growth. Agapanthus umbellatus is another plant well worth a trial near water. If planted in an elevated position among rocks, it will be much more likely to succeed than when on level ground. It flowers freely in summer, and should be well supplied with water at the roots when making its growth. Solomon's seal, owing to its long, arching stems, is well fitted for planting close to water. It looks best in a bold mass. When so treated the ground should be planted with some carpet plant, such as Sedum glaucum, which will look well after the stems of Solomon's seal have died down in winter. The common hart's tongue fern (Scolopendrium vulgare), being evergreen, is also very effective when planted in groups in such situations. The deep green fronds form conspicuous objects, particularly in autumn and during the winter months. Garrya elliptica, when planted among rocks, and so as to allow its drooping catkins to show their true character, has a graceful appearance. Bocconia cordata planted on grass at a distance of, say, 6 feet from the water makes a capital water-side plant, its handsome leaves and branching spikes of white flowers being very effective. It grows freely, and is easily increased by dividing the roots in autumn or spring. Lythrum roseum superbum grows freely when planted on the margin of water, and so used is a grand plant. The same may also be said of Spiræa aruncus and venusta, the white and pink flowers of which are very showy in summer. They should be planted either close to the edge of the water or at a little distance off. They should have plenty of moisture at their roots during summer, in order that they may become portly specimens and well flowered. White and yellow brooms when planted so as to hang over and almost touch the water look well; a somewhat elevated position suits them best. Iris fœtidissima, being hardy and retaining its brightly colored variegated foliage through the winter, is well adapted for planting close to water. Its dark blue flowers are produced freely in summer, and its fruit in autumn is always interesting. For summer decoration nothing is better suited than the various kinds of sub-tropical plants, such as palms, dracænas, pandanads, and ficuses The pots in which these are growing should be plunged in the grass, or the soil should be carpeted with some suitable plant. Ricinus gibsoni, the dark leaved castor-oil, L. compactus (green leaved), various kinds of tobaccos, solanums, wigandias, ferulas, cannas, eucalypti, and variegated abutilons are all effective plants, either singly or planted in masses. The common yellow and Scotch laburnums also look well near water if elevated so that the drooping habit of the branches and long racemes of golden flowers can be seen to advantage.—*E. Molyneux, The Garden.*

PLANTING: PREPARATION OF THE SOIL.

PLANTING and pruning are the most important operations during this month. The first thing to be considered in planting fruit trees is the preparation of the ground, for if this is not in a good condition it is almost waste of time and money to plant; so if this operation has been delayed no time should be lost, always bearing in mind that fruit tree planting, as a rule, is intended to be permanent, hence it is very important that a good soil and situation should be chosen. Should the ground intended to be planted be damp, means should at once be taken to thoroughly drain it. Strong heavy ground should never have drains more than three feet deep, and if a foot of rubble can be placed on the top of the drain-pipes so much the better. I have planted fruit trees in borders concreted for eight

SOLDANELLA ALPINA.

or nine feet from the wall, and also on well-drained borders without concrete, and from experience I much prefer the latter. When planting the latter, I prefer placing a good barrowful of broken brickbats under each tree, with a few slates laid flat so as to form a sort of table to plant on. Planted in this manner with about 18 inches of good loamy soil, they will form a mass of fibry roots, which being kept near the surface are well under command as to feeding and watering. In transplanting remember to take up a sufficiently large ball. By the diagram, where the position of the circle indicates the usual relative size of the ball, it will be seen that most of the feeding roots are outside the circle, and consequently sacrificed if the ball be too small.

PRUNING.

The pruning of fruit trees should be pushed forward as expeditiously as possible. Old-established trees should be looked over carefully, removing all small, crowded shoots; and should the middle of the tree be a mass of small growths, a few large branches should be entirely removed, which will be found better than having to cut away so much young wood.

MANURING.

Advantage should be taken of frosty mornings to place a good dressing of rotten dung on the surface of any fruit trees that are weak or unhealthy; this will encourage surface roots to form. Where the ground is of a strong, heavy texture, dig between the rows of dwarf bush trees so as to allow the air to pulverize and sweeten the soil, always being careful not to dig too near the roots of the trees or bushes. Where the ground is of a light, sandy nature, it is better not to disturb the soil, merely hoeing and keeping the ground free from weeds. This is a good time of the year for placing a good dressing of manure on the surface of the ground of the latter nature. If strawberry beds have not had a good dressing of manure placed on the surface of the beds, it should now be done—or even over plants and all; it will do no harm if spread broadcast over the whole beds.

WALL TREES.

The nailing and pruning of wall trees may be proceeded with as opportunity offers. I prefer nailing the north and east walls first; on south and southwest walls we prefer leaving all young shoots of peaches, nectarines, and apricots loose from the walls at present, merely securing all the older shoots so as to save time when the busy season arrives. Let any one try this plan, and they will find that these trees will flower a week or ten days later, which often means a crop or no crop. It is a good plan before nailing the trees, or even after, to give the walls and trees a good washing with soapsuds either with the syringe or the engine.—*F. Smith, in The Gardeners' Chronicle.*

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